POWER

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Big Words Humanized

ADAPTABILITY

means doing the next best thing in the handiest way.

EFFICIENCY

is knowing just how and fitting it to just when.

LOYALTY

consists in being decently considerate of the Boss.

RESPONSIBILITY

lies in having grit enough to risk a call-down.

OPPORTUNITY

is the same thing as being born lucky.

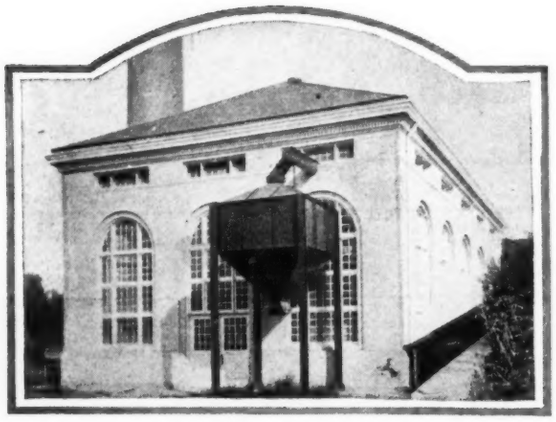
RELIABILITY

shows the capacity for staying put longest.

INTEGRITY

is the Sunday name for plain weekday honesty.

By FREDERICK MOXON



Central Heating Plant of the Colorado State College

Some of the features of a steam-heating plant serving a group of college buildings scattered over twenty acres of campus, particularly coal- and ash-handing equipment and tunnels for steam and return lines.

STEAM for 42,000 sq.ft. of radiator surface in 26 buildings widely scattered over a campus containing 20 acres is the demand made on the central heating plant of the Colorado State Agricultural College, Fort Collins, Colo. The building that houses the boiler plant is shown in the headpiece. It is located fairly central to the group of college buildings and at the same time has good side-track accommodation from the main line of a railroad that passes through the college grounds.

As the college is a state institution dependent for support on appropriations made by the legislature, the building program was governed by the funds available and the equipment was installed in units instead of being completed at one time. At present there are two 234-hp. Stirling boilers in operation, but the building is designed to accommodate four more units of the same size and type.

Northern Colorado lignite slack is burned under the boilers on stokers of the chain-grate type. When the plant was first put in operation, the stokers were fed by hand with coal brought into the boiler room in small industrial cars; a later appropriation, however, enabled a Jeffrey mechanical coal-handling equipment to be installed.

A side track runs along the outside of the building, and the coal is delivered from the cars into a track hopper 12 ft. wide and 20 ft. long, made of ¼-in. plate. A standard plate feeder receives the coal from the track hopper and feeds it to a 24 x 24-in. single-roll crusher, as shown in Fig. 1. The crusher is used to reduce the size of lump coal whenever it becomes impossible to obtain enough slack.

The crushed coal is discharged into a ¼-in. steel spiral conveyor 12 in. in diameter and is carried up a slight incline for a distance of 30 ft., being then fed direct to the V-bucket elevator-conveyor shown in Fig. 2. This elevator-conveyor has 16 x 20-in. steel buckets with reinforced lips spaced 30 in. apart and has a capacity of 30 tons per hour. The vertical run is 23 ft. between centers and the horizontal run is 52 ft. between centers. The latter carries the coal to the hoppers in front of the boilers.

In working out the coal-conveying system it was necessary to take into account a future installation of steel storage bunkers which will be erected as soon as sufficient appropriations have been made. The driving mechanism of the coal-handling unit has been calculated on the basis of the completed installation and so is of such size and strength as to be able to care for the units to be added later. The installation at present uses wooden supports for the conveyor, but these are only temporary.

The ash-handling equipment, which is also of the Jeffrey type, is located in the basement; beneath the stokers is a horizontal drag chain conveyor 48 ft. between centers, as shown in Fig. 3, into which the ashes are discharged. It runs at a speed of 60 ft. per min. and has a capacity of 8 tons per hour. The ashes are carried along by the bottom strand in a cast-iron trough, the returning strand of chain being carried on angle-iron guides at the top. This conveyor discharges the ashes into a vertical elevator, Fig. 4, which passes up through the main boiler room to the ceiling and there empties the ashes into a spiral conveyor by which they are delivered to the steel storage bin outside. This bin, which can be seen in the foreground in the headpiece, is elevated so that a wagon can be driven under it and is provided at the bottom with a large clamshell valve through which the ashes may be discharged. The entire ash-handling unit is driven by one motor, so that all sections start at the same time.

The steam pipes and the return lines are installed in 4000 ft. of concrete tunnels, made in two different sizes, as shown by the sections in Figs. 5 and 6. The main tunnels are rectangular and are 5 ft. wide and 6 ft. 3 in. high, inside measurements. The floor and sides are not reinforced, but the roof is strengthened with triangle-mesh reinforcing wire. The walls and roof are 6 in. thick, except at wagon-road crossings, where they are somewhat heavier and more strongly reinforced. In two places the tunnels pass under the Colorado & Southern R. R., and at these points they were built very heavy to withstand the load due to traffic.

The smaller tunnels, or branches, are also rectangular, measuring 3 ft. wide and 4 ft. high inside, and the walls are 4 in. thick, the top alone being reinforced. At intervals in the small tunnels standard 24-in. cast-iron manholes are located, with ladders leading down into the interior. Tile drains are built under the floors of all the tunnels throughout their entire lengths. The pitch of the return pipes in the tunnel is such that all condensation can be returned to the boilers by gravity.

An interesting feature of the tunnel construction is the provision made for taking pipe and fittings into the tunnels. At the point where a sharp turn or corner occurs, each branch is continued on and upward at a

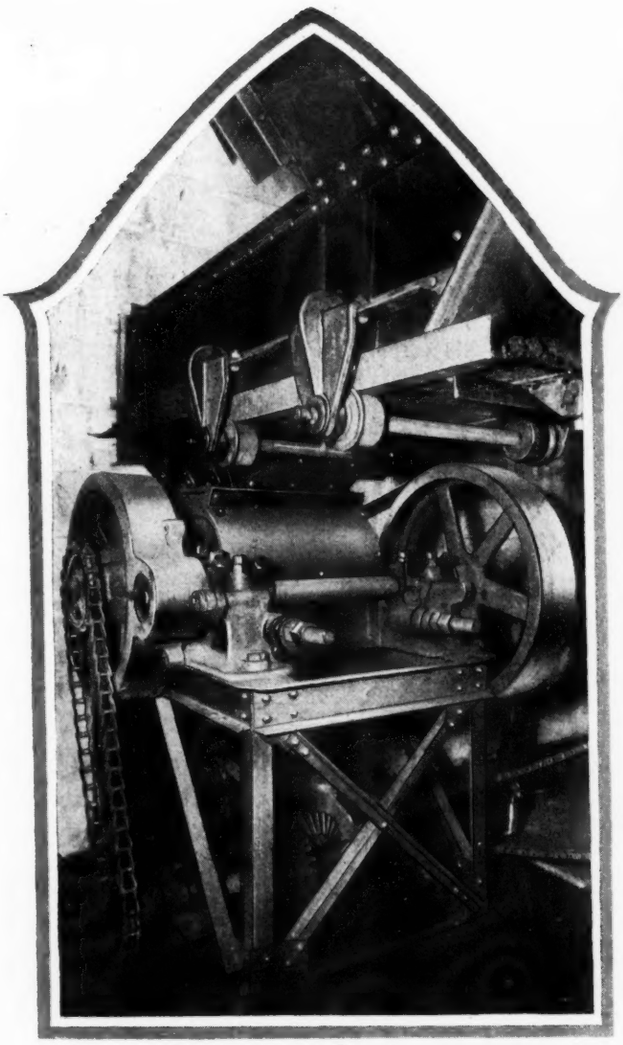
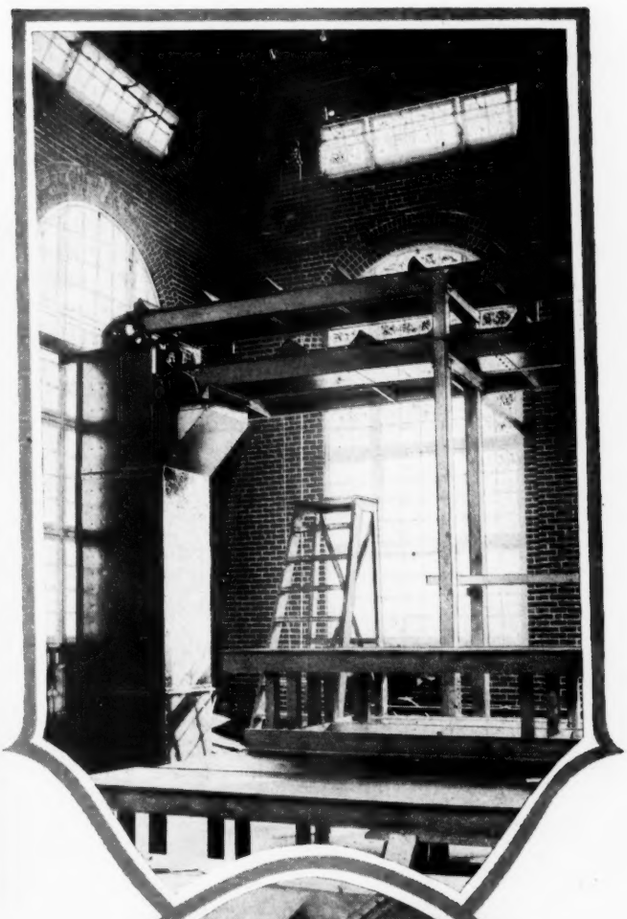


Fig. 1. Crusher for Lump Coal

Fig. 2. Bucket Elevator-Conveyor for Coal



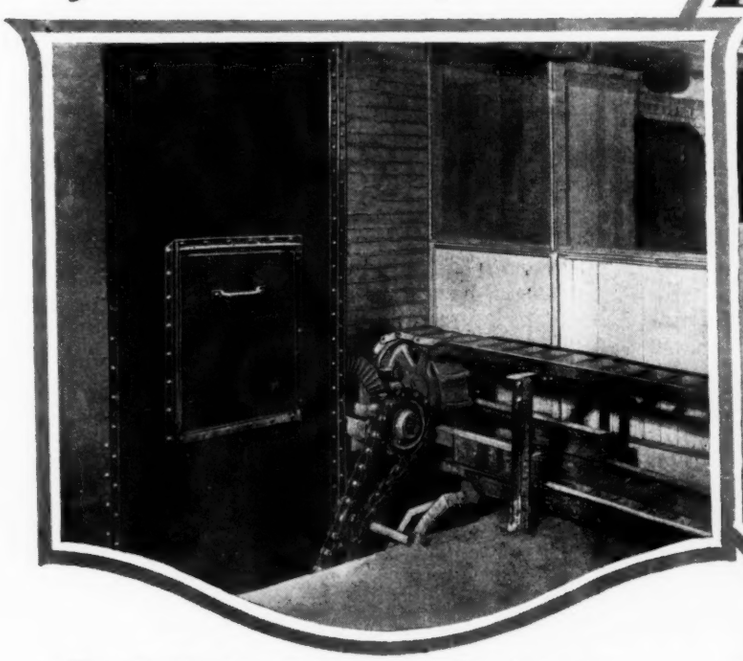


Fig. 4. Vertical Elevator for Ashes

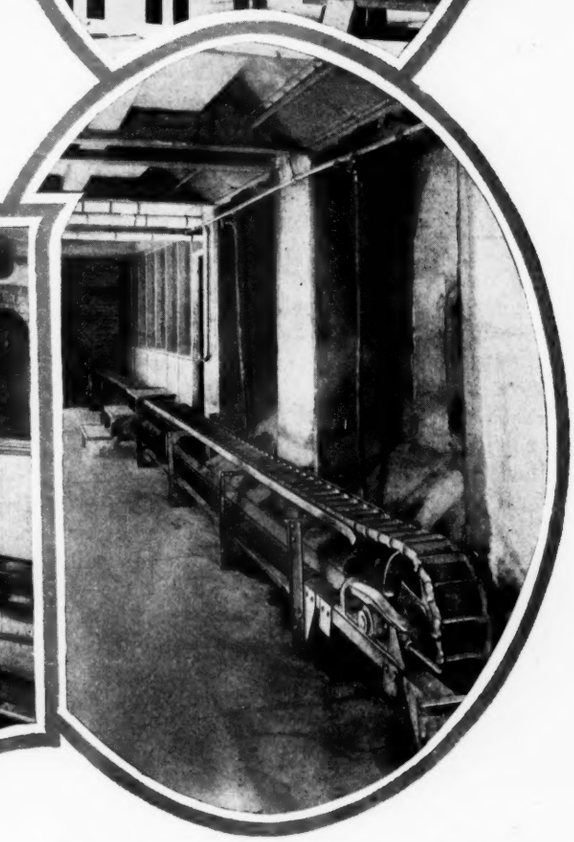


Fig. 3. Drag Chain Conveyor for Ashes

gentle slope to the surface of the ground. These concrete runways leading to the outside enable piping and other material to be taken into or out of the tunnel on a small truck. The openings at the ground surface are closed by large steel doors.

All parts of the tunnels are lighted by electric lamps placed 12 ft. apart. They are arranged so that the entire tunnel may be lighted at one time, or, if desired, any section may be lighted alone. Thus, the workmen may light up the section ahead, as they go through the tunnel, and switch off the lights in that section when they pass to the next. One or more lamps may be removed and extension cords attached for the use of lamps in close-up work in any part of the tunnels.

In the large tunnels the pipes are laid on rollers held by cast-iron chairs carried by brackets. The brackets are bolted to vertical I-beams held in the concrete wall of the tunnel and are adjustable up or down on the I-beams. These beams were set in position in the forms for the concrete and when the concrete was poured and the forms removed they remained half embedded in the wall, spaced 12 ft. apart. All the pipes are free to go and come on the rollers except where they are anchored. Between the points of anchorage expansion joints are used.

On the opposite side of the main tunnels vertical wooden posts, made of 2 x 4-in. stock with two edges beveled ½ in., are set into the wall flush with the surface and on these uprights the electric wires are carried. The wooden posts were given two coats of boiled linseed oil before they were set in the concrete forms, so as to prevent them from absorbing moisture.

In the small tunnels the method of carrying the pipes is different. When the concrete walls were built, angle irons were set in across the tunnel about 3 in. below the roof. From these crosspieces the smaller sizes of pipe are suspended by common ball-and-socket hangers, allowing the pipes to swing freely in any direction except at the anchorage points.

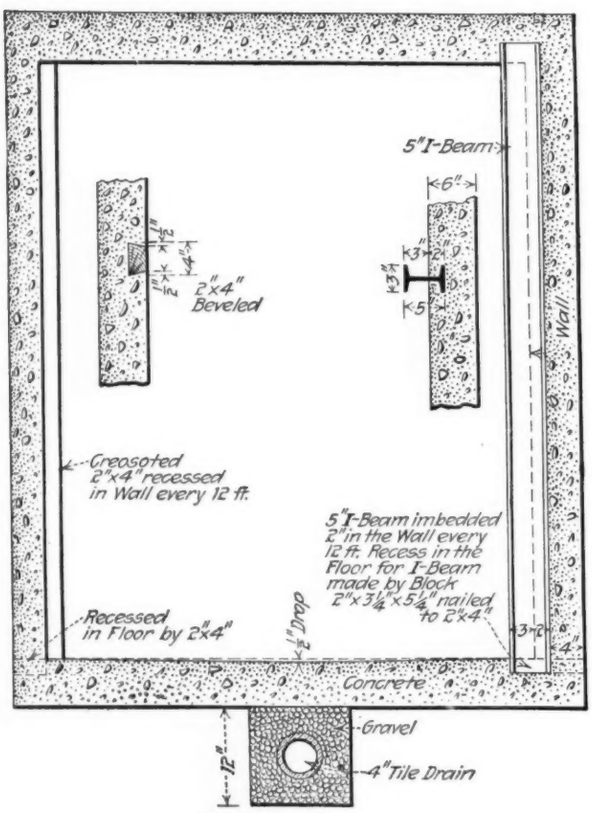


FIG. 5. CROSS-SECTION OF MAIN TUNNEL

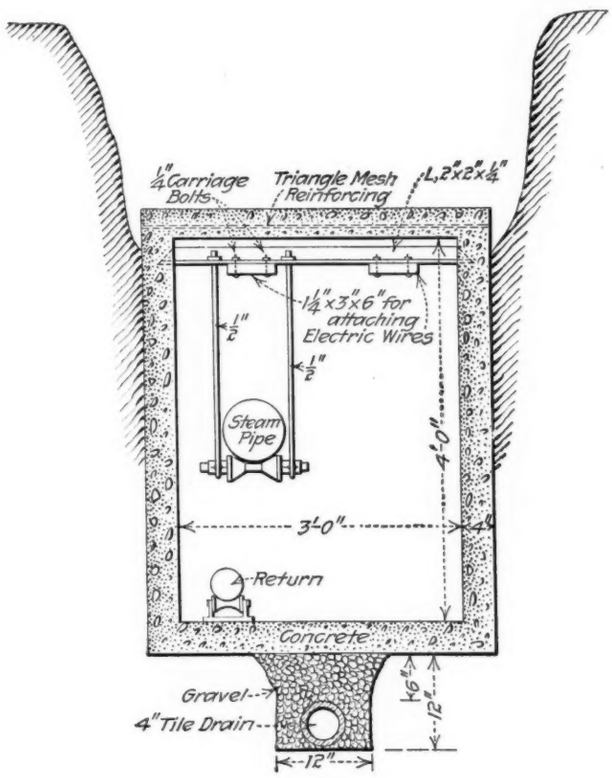


FIG. 6. CROSS-SECTION OF BRANCH TUNNEL

New York Workmen's Compensation

A night engineer employed in a New York piano factory was fatally burned because of a back draft in the ignition of highly combustible refuse which he was burning in his employer's furnace; and his executors sued to recover damages on the ground that the furnace had been negligently permitted to remain in a condition rendering it dangerous as a means of disposing of refuse.

It is held, however, by the Appellate Division of the New York Supreme Court that the employment was one of those hazardous occupations covered by the New York Workmen's Compensation Act, and that an ordinary personal-injury suit would not lie in the absence of a showing that the employer had failed to secure payment of compensation under the Act, thereby permitting bringing of suit, as distinguished from an application for an award under the Compensation Act. (Nulle vs. Hardman, Peck & Co., 173 New York Supplement, 236.)

Because of the nature and extent of the equipment needed, the successful exploitation of oil-shale deposits involves large capital, as well as technical chemical ability.

Fuel Conservation in Massachusetts

By THOMAS HAWLEY

GREAT good has been accomplished and much coal saved for New England by the fuel-conservation plan carried out in Massachusetts. A sufficient number of practical first-class engineers were selected, and each man was assigned not over ten steam plants in his vicinity. To these plants he was expected to act in the capacity of visiting and advising engineer. His employer was asked to donate the time away from his own plant necessary for the engineer to do this work. This plan was followed in every city and town where there were more than eight steam plants, and with few exceptions every city and town was so organized. If a town had fewer than eight steam plants, those plants were inspected by field engineers sent out from headquarters in different parts of the state.

Worcester was the first city organized and had, in addition, the effective coöperation of a committee of manufacturers toward the same end. The work accomplished was noteworthy, and there is positive record of large savings in coal as a result. Fall River and Lowell were also well organized, and very satisfactory results were obtained. Cambridge and Somerville, were inspected 100 per cent. under the chairmanship of A. H. Eldredge, M. E., with most gratifying results, and in the smaller places the work was equally effective.

The visiting engineers in each locality were organized into a committee for that town and suggested changes of practice or equipment were made after this full committee had debated and agreed upon what should be done. All recommendations of visiting engineers had therefore to be approved by the full committee. These men not only inspected steam plants, but made recommendations in an advisory capacity, and their attitude was always to be that of coöperating with the management toward more economical generation and use of power. Each of the plants assigned to a visiting engineer was to be visited by him at different times during the winter to report upon what changes had been made and the economies effected and what plans were on foot for further saving.

Classification of Plants That Were Inspected

At the time of the armistice some of the engineers had made several visits to every plant under their charge. In Boston forty engineers were drafted for this work, divided into three committees, each committee meeting once a week, and it is probable that the work of conservation will continue in many plants even though the organization has been discontinued. The plants inspected were divided into three classes. In class A were plants which were apparently well equipped, in the fact that they were in good physical condition, having feed-water heaters, all exhaust steam used, heating returns saved, traps in good condition, pipes well covered and settings in good condition. Class B included plants in which some changes were suggested, but not very extensive. Class C comprised plants in poor condition, without proper equipment.

Of 250 power plants (not including large electric or refrigerating plants of the city institutions of Boston) that had been fully inspected in Boston up to the time of the armistice, 120, or 55 per cent., were in Class A, and 50, or 23 per cent., in Class B; 45, or 22 per cent., were in Class C or had not been classified. Only two of the Class C plants used over five tons of coal a day, so that the whole tonnage of the poor plants was very small. This showing indicates that 78 per cent. of the plants of Boston were in such physical condition that skilled engineers could find very little to suggest in the way of new equipment. This figure will also fairly represent the condition of the plants in the neighboring cities and towns. And yet nearly all these plants had reported savings in coal ranging from 5 to 45 per cent. in comparison with similar months in previous years, and if the work had been kept up, a still greater saving would have been shown. This saving came by the constant watchfulness on the part of the operating force and stoppage of the little leaks that so steadily make up large losses.

Response of Owners to Suggested Changes

Of all these plants, only two used the CO_2 machine, and neither the engineers nor the owners took kindly to the suggestion that such a machine might be profitably employed. No report was received that any owner installed one at the suggestion of the visiting engineers, although every suggestion was, with rare exceptions, well received and fully considered.

Few plants were reported as using the draft gage connected over the fire, but the installation of this device was recommended in many cases as an aid to better conditions, particularly where heavy or exceptionally thin fires were observed, and many plants have installed them, deriving much satisfaction from their use. The proper draft over the fire was sometimes determined by the CO_2 machine, but commonly set at about 0.3 in. In many of these places the fireman no longer watches the steam gage, but watches the draft gage instead, and if it starts to go down he immediately knows his fires are getting thin and places a small amount of coal on the fire in such a way as will bring the draft gage back to proper position again. Unconsciously, these men have thus become accustomed to firing light and often with marked improvement in economy. If the inspection work had continued, many of these instruments would now be in use with a considerable change in the practice of firing.

Another interesting fact observed was that a great majority of moderate-sized plants in this vicinity are operated at a rate of combustion of 6 or 7 lb. per square foot of grate per hour. There is a very strong opinion among firemen and engineers that this is about right, while it was the recommendation of the majority of the visiting engineers that this rate should be increased. This could be done in some cases by cutting out a boiler, and in others by cutting down the area of grate surface. This proved not so easy a task because the firemen, firing the same as before, would lose steam pressure,

and had really to be educated to firing under the new conditions. But when they later became accustomed to the change, they had no difficulty in keeping up steam with less fuel expenditure. In one case reported, the area of grate was gradually cut down from 36 sq.ft. to 18 sq.ft. with a marked increase in economy. There is opportunity here for considerable missionary work among engineers and firemen, and visiting engineers were considering how best to handle that problem at the time the work ceased with the end of hostilities.

Condition of Boiler Settings and Baffles

Another important saving was effected by covering boiler settings with plastic, even settings that showed no positive indication of air leaks. In all these cases the visiting engineers reported that increased economy had been obtained. Little or no attention appears to have been paid to obtaining positive knowledge concerning the condition of the flame baffles in water-tube boilers. The great majority of engineers have never made any tests in this particular, nor made any special effort to keep the baffles tight. It was the opinion of the visiting engineers that much could be saved if the baffles were repaired at regular intervals, and this was one of the matters slated for later discussion. Where piping was found uncovered, the saving to be obtained by covering appeared to be quite clear, although there was considerable objection to the suggestion that feed-water pipes should be covered between heater and boiler, even on the part of the engineers operating the plants.

Very few plants were found that kept any intelligent records of the work they were doing. Some plants—not over 15 per cent.—had feed-water thermometers, but few had any means of weighing coal or measuring water, and suggestions that apparatus for these purposes be purchased were not well received by the owners. The attitude adopted by most owners was one of co-operation during the war, as a war measure, wherever a saving could be clearly shown, as in the case of a more efficient feed-water heater, covering steam pipes, using exhaust steam, saving waste returns, etc. But any refinements or helps that might make the work of the operating force easier and more sure of better operation were not so readily considered, although owners were anxious enough that the men should be economical with such apparatus as they then had.

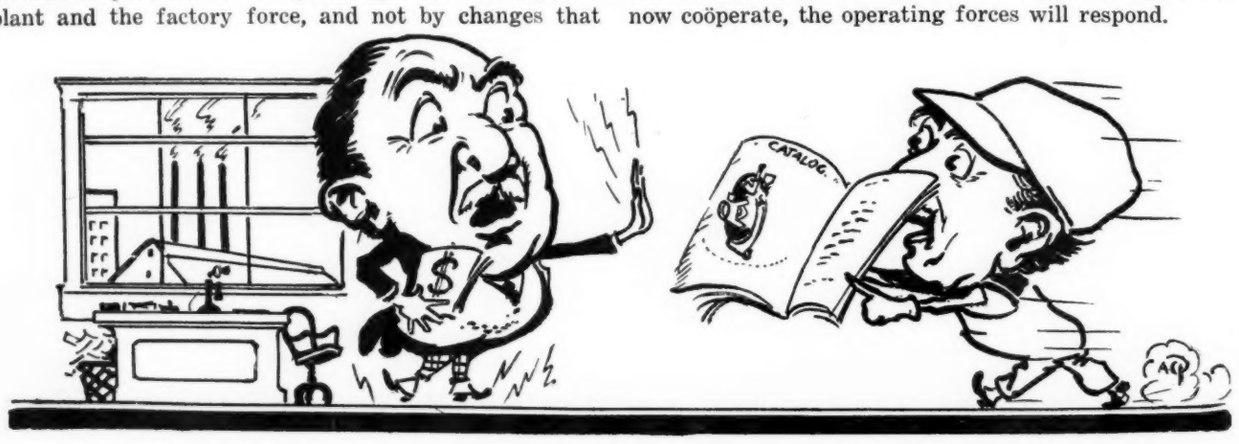
There seems to be no doubt that much coal has been saved in Massachusetts, but it has been done by the earnest coöperation of the operating force in the power plant and the factory force, and not by changes that cost the owners money. The opportunities for even greater saving exist, and it will be regrettable if this does not continue. The owners of steam plants should not expect their operating force to accomplish this without some assistance or at least recognition of its accomplishment.

Here is one case that was reported: After wrangling and protesting against the indifference of the superintendent, an engineer made some changes that he believed would improve economy. The coal bill for November had fallen from 111 tons in 1917 to 65 tons in 1918. This could be accounted for by the comparative mildness of last November, but the engineer insisted that the heating was completely by exhaust steam and not all of that was used, so the saving did not come there. This saving, at the price of coal in Boston, nets the owner over $400 per month, and yet the engineer was not even thanked. He now has a plan to make a further saving of about $100 per month by some other small changes, but he has met the same violent opposition as before and is treated with scant courtesy. What is that engineer to do? His professional pride compels him to insist on those changes, but his employers' attitude encourages him to let the matter drop, and as the war stimulus is no longer upon him, that is what he will doubtless do.

Conclusions Drawn from Plant Inspections

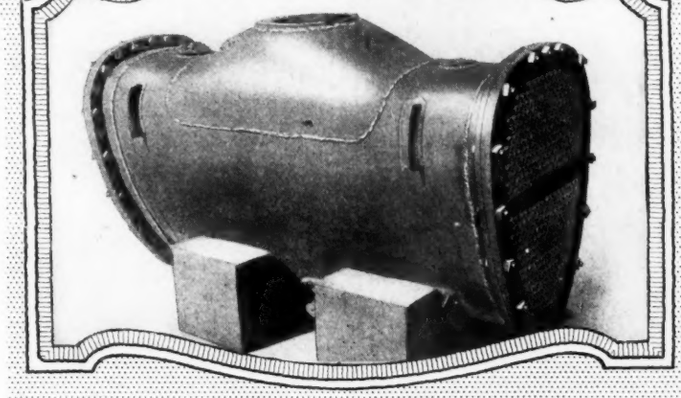
Inspections have shown that many plants apparently well outfitted could be rearranged with great improvement in economy. They have shown no attempt whatever to furnish plants with recording instruments or to keep proper operating records. They have shown that large economies can be effected whenever the operating force concentrates its energies to that end. They have shown that no effort has been made by the owners to secure the best from their employees, but rather a disposition to hamper an engineer whenever he makes a suggestion that may involve expenditure.

More than ever it has become apparent that great savings can be effected through the constant efforts of the operating men, but it cannot be done until good performance in the power plant is rewarded, for then the operating men have an incentive to save. Since inspections ceased there have been many evidences that the work of conservation will go on, for a time at least. The operating forces in Massachusetts are more intelligent than ever before and have shown what they can do. If those for whom the savings are made will now coöperate, the operating forces will respond.



Some Examples of Electric Welding

By J. O. Smith



ELECTRICITY as a means of welding in repairing cracks or breaks in metals, salvaging defective castings and for cutting purposes, all included under the general head of electric welding, is being used to a greater extent than ever before. Although comparatively simple in theory, the development of the use of electricity in this form has been slower than in any other service in which it has been applied. This slow growth is probably due to two causes—the scarcity of skilled operators and apparatus suitable for performing the actual operation.

During the last two years, however, arc welding has made great strides, and undoubtedly a great stepping stone, by means of which it has attained greater prominence and the confidence of engineers in general, was through the successful welding of the damaged parts of the interned German ships at New York at the outbreak of war in the spring of 1917. The work done on the engines of the damaged German ships demonstrated to the engineering world in general that electric welding could be depended upon to make lasting repairs, no matter how large the part to be welded or the character of the metal. In these ship repairs, made by the Wilson Plastic-arc system, the intense heat of the arc was used to bring the metal to a melting or fusing point. This arc is convertible, which permits of its application to any desired point.

The arc itself is produced between the material to be worked, which is connected to the positive side of the circuit, and a rod, usually of the same material, which is connected to the negative side. This electrode of welding metal is so proportioned that the amount of the elements burnt out by the arc is compensated for. Thus the chemical resultant in the weld is predetermined.

The system under discussion employs a standard flat compound 35-volt generator to feed a special constant-current controller. The carbon pile and a solenoid that operate the arc, are in series with it, so that the current through the arc is controlled by the automatic variation of the resistance of the carbon pile in response to the pull of the solenoid. The pull of the solenoid is balanced in turn by a spring connecting from a leverage, and the current adjustment is made by changing the leverage. The pilot motor, which may be controlled by a switch from the welding-tool handle, regulates the leverage so that the operator can change the current at the arc, if necessary, without leaving his work or extinguishing the arc. Fig. 11 shows a two-arc 300-ampere welder. A few applications of the work accomplished by electric welding in boiler and other industrial work are shown in the illustrations. That welding can be done in confined spaces is shown in Fig. 1, where boiler tubes are being welded to the tube sheet of a locomotive type boiler. In Fig. 2 are shown repairs by arc welding to a boiler, some of the rivets of which have failed, resulting in a leaky seam.

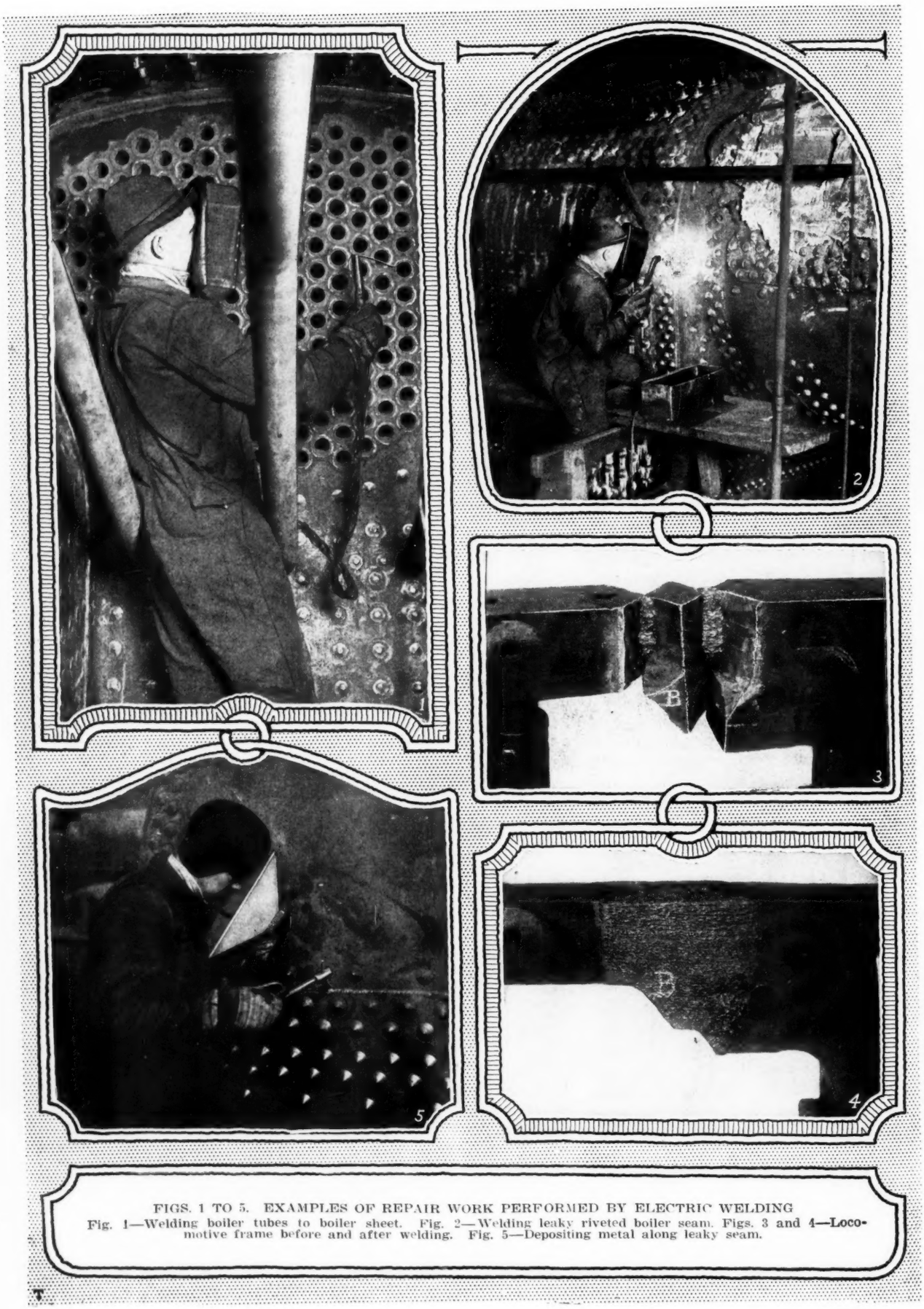
Another example of welding, where the service is severe, is illustrated in Figs. 3 and 4, which show before and after welding views of the repair of a locomotive frame. The frame was broken at *B*, and in cutting out the defective part a large space was left between the two ends of the frame. The filler *B* is a new piece of metal set in and tacked with the welder and is ready for the completion of the job, which is shown in Fig. 4. The work required 41 lb. of electrodes, 125 to 150 amperes at from 35 to 40 volts. The welding time for one welder was 30 hours, using in that time approximately 165 kilowatts of electric energy.

Figs. 5 and 8 are examples of riveted seams on a large oil tank that have opened and are being welded tight, three welders working on the job at the same time, Fig. 8. A close-up view of the welding shown in Fig. 5, illustrates the method employed in depositing metal along the leaky seam.

That electrical welding is suitable for commercial work is shown in Fig. 6, where there are illustrated a number of welded joints of $\frac{5}{16}$-in. plate used for ventilator pipes.

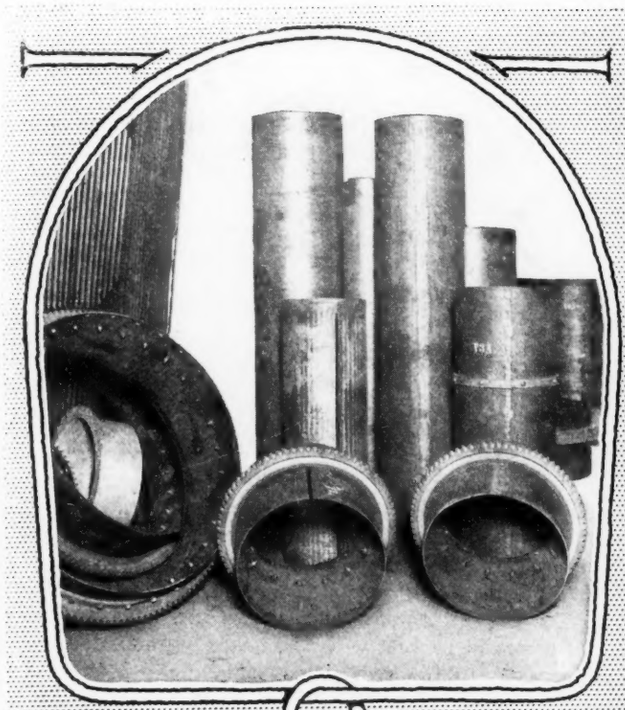
The adaptability of this method of welding for light work is again shown in Fig. 7, which is a sheet-steel fuel-oil tank welded complete without the use of rivets. This work was done by the Squantum works of the Bethlehem Shipbuilding Corporation, as was also the welding on a pressed-steel condenser shown in the headpiece illustration. This condenser is said to be the first of its kind ever welded, and this method of joining a metal condenser has been adopted as a standard method of construction by the Bethlehem Shipbuilding Corporation.

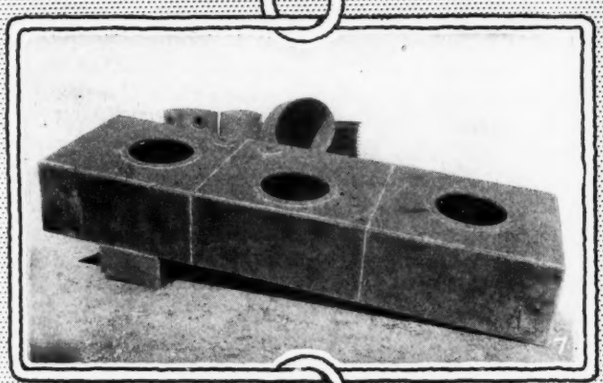
Frequently pulleys, flywheels and gears are fractured, and in most instances the damaged member is replaced by a new one, whereas they can be repaired by welding

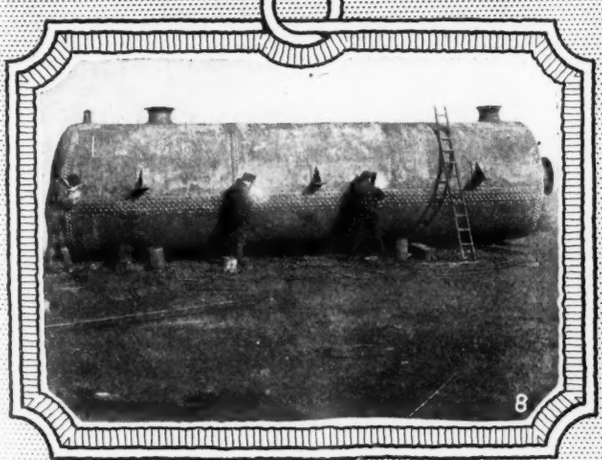


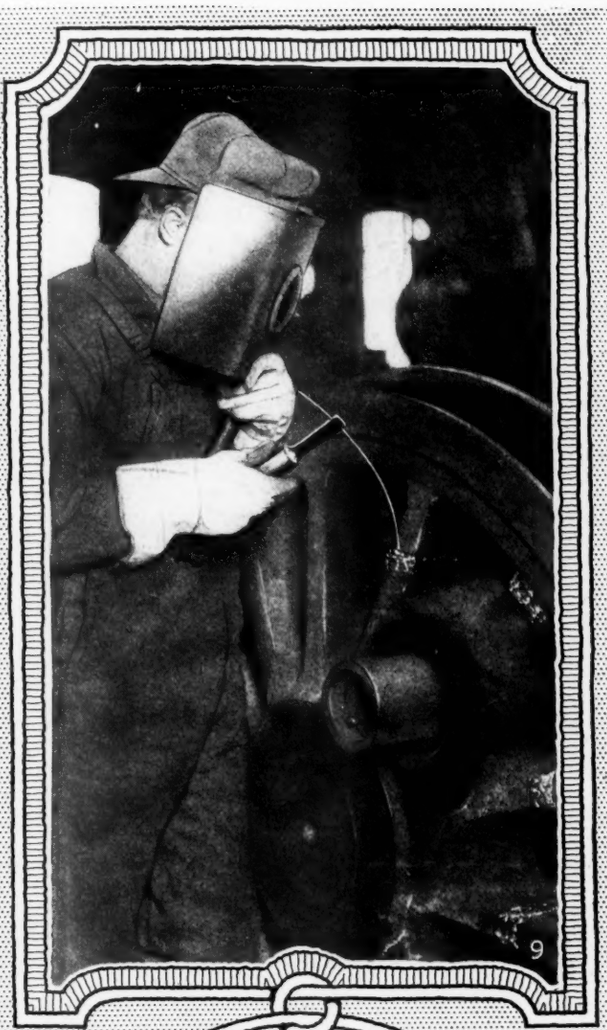
FIGS. 1 TO 5. EXAMPLES OF REPAIR WORK PERFORMED BY ELECTRIC WELDING

Fig. 1—Welding boiler tubes to boiler sheet. Fig. 2—Welding leaky riveted boiler seam. Figs. 3 and 4—Locomotive frame before and after welding. Fig. 5—Depositing metal along leaky seam.









FIGS. 6 TO 10. MORE EXAMPLES OF ELECTRIC ARC WELDING

Fig. 6—Welded ventilator piping. Fig. 7—Welded oil tank. Fig. 8—Three welders working on one job. Fig. 9—Welding locomotive driving wheel. Fig. 10—Filling in a crank arm.

as is shown in Fig. 9, which is an example of heavy repair work on a main driving wheel of a locomotive. It is evident that such a weld will be subjected to much more severe operating conditions than would be the case of pulleys, etc.

Fig. 10 establishes the fact that a great deal of time can be saved by using two welders at once on the same job. The illustration shows the filling in of a cast-steel engine crank arm preparatory to reboring.

That welding, if properly done, can be applied to boiler work was demonstrated in the case of a boiler

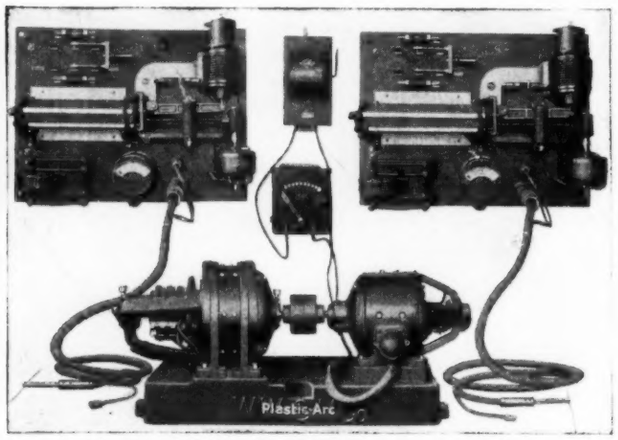


FIG. 11. TWO-ARC 300-AMPERE ELECTRIC WELDER

header that was welded recently by this system. A pressure test was then applied to the boiler to determine its holding qualities. After the ordinary test pressure, a special pressure of 3500 lb. per sq.in. was applied, and not a single defect, not even a pinhole, developed. The only outward evidence of the unusual pressure being applied was the bulging of the header. No machine could be procured around Chicago that could provide a higher pressure on the boiler, and the tests were considered conclusive evidence of the holding qualities of the weld.

Tocknell Compressed-Air Vibrator

Most piston movements are controlled by a mechanism outside of the cylinder, but in the Tocknell compressed-air vibrator, Fig. 1, patented by Charles W. Tocknell, Kenilworth, N. J., the control of the piston movement is by means of valves that work in three so-called cross-walls, the movement of the cylindrical valves being controlled by the piston striking them and thus moving them from one end of their travel to the other. Each valve has a longitudinal bore extending through the greater portion of its length and two transverse ports that communicate with the longitudinal bore. Each valve is also provided with a head at both ends, and one head of each valve at opposite ends has a transverse groove connecting with the longitudinal bore of the valve.

A piston rod carries two pistons. The rod also passes through the center of the spacing collars. The piston has a longitudinal bore from one portion to the other, which connects with a transverse bore and which aligns with a similar transverse bore.

In operation, with the parts in the position shown in Fig. 2, pressure is admitted through the pipe *A* into the chamber *B*, and passes through the port *C* to the bore *D* of the valve *E*, and through the groove *F* to the space between the stationary wall, and the piston *H*. The pressure will force the piston *H* toward the right, and the piston *J* with it. The air trapped between the piston *H* and its cylinder head will pass through the

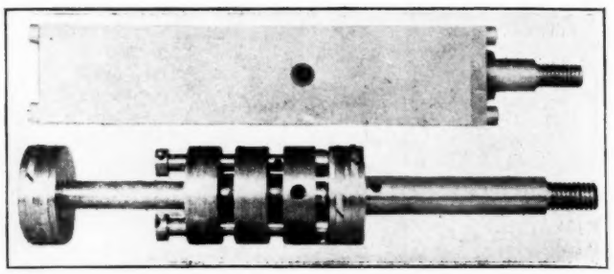
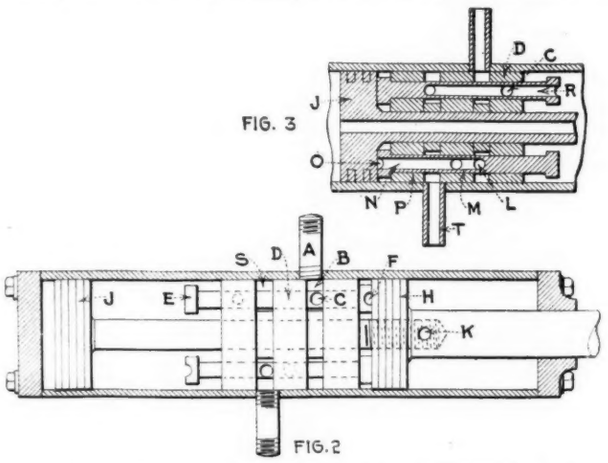


FIG. 1. CASING, PISTON AND VALVES OF VIBRATOR

port *K*, and the bore in the piston rod to the space between the piston *J* and its cylinder head.

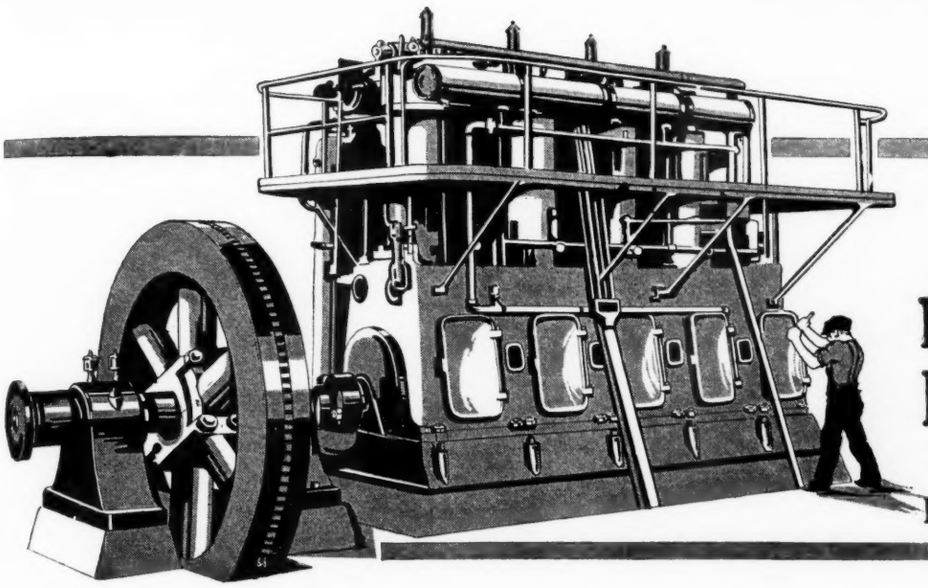
When the pistons have traveled a distance sufficient to bring them to the position shown in Fig. 3, the piston *J* comes in contact with the heads of the valves and forces them to the position shown. This brings the port *C* within the wall *D* and closes this port. This movement of the valve also brings the port *L*, which has been closed within the wall *M*, into the chamber *B*, Fig. 2, when the pressure will pass through the port *L*, Fig. 3, the bore *N* and the groove *O* to the space between the piston and the cross-wall *P*. This will force the piston *J* toward its cylinder head. At the same time the pressure that has been accumulating between the piston *H* and the cross-wall *D*, Fig. 3, is free to escape through the bore *R* of the top valve and the port *C*, which, in the new position of the valve, is situated in



FIGS. 2 AND 3. SECTIONAL VIEWS THROUGH AIR VIBRATOR

the chamber *S*, Fig. 2, thus permitting its discharge to the exhaust pipe. The cycle of events then follows as long as pressure is admitted to the cylinder.

There is no necessity for screwing any kind of packing up tight. If the rod is in good condition the packing can be made tight enough by merely screwing up the gland nuts with the fingers while the packing is cold. The application of steam to the cylinder and around the rod will cause the packing to become steam-tight.



Talks on DIESEL Engines

by L. H. Morrison

X—The class learns how to determine when a valve needs regrinding, how to perform that operation and how to time the action of the inlet and exhaust valves.

"LET'S see—I promised Sandy I'd take up valve grinding tonight, didn't I?" Egan announced. "Yes—and Sandy's not the only one that wants to hear about it," said Woods. "Seems to me I've seen more about that than about any other subject connected with Diesel engines."

"Well," remarked the chief, "in my opinion it's worth discussing. A lot of good engines have been damned because the engineers didn't know how to grind the valves."

He spread out a sheet showing a sketch like that in Fig. 1, before he continued his story.

"I've noticed that many engineers will remove the dash-pot and spring and grind by giving the valve a continuous rotating motion. The proper way is to remove the spring and insert a light spring *A*, as I show here. Leave the dashpot *B* in place to act as a guide in keeping the valve stem central. The idea of the light spring is to lift the valve off its seat when the pressure is removed. Put a light coat of extra-fine emery paste on the seat, press the valve down until the two surfaces to be ground are in contact, and rotate a half-turn back and forth, letting the valve rise off the seat at frequent intervals. Apply more paste and rotate over the other half of the cage seat. This will grind the whole. The idea of allowing the valve to lift occasionally is to prevent the seat from being ground convex. If this is not done, the edges only will be ground. As to the width of the ground part of the seat, a sixteenth of an inch is ample. I always like to see this much ground so that it will reflect light, like a mirror."

"I don't see how you are going to grind that good, when every time an engine is shut down there is always a rush to get it back into service quickly," Woods argued.

"It's always desirable to get an engine back into running order as soon as possible and on this account I'm afraid some of our valve grinding has been more on a 'lick and a promise' order. This is because we have no extra cages. I have asked for two extra cages and valves, and, when they arrive we will arrange to keep the spare ones ground and ready. This will allow us to use plenty of effort on our grinding. Over at the Clarksburg plant they grind the set just as soon as it has been removed from the engine; then the cage and valve are coated with lubricating grease to keep the bright surfaces from rusting."

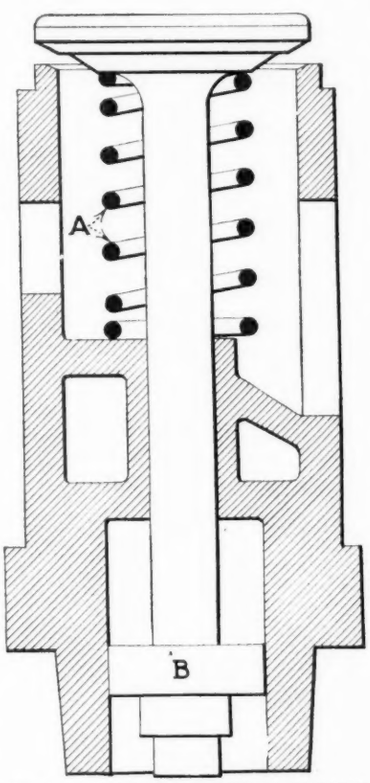


FIG. 1. USE OF LIFTING SPRING IN GRINDING VALVE

"J. R.," Kelly spoke up, "you tell us how to grind valves; but what gets me is—how am I to tell when a valve needs grinding without taking it out to see?"

"Well, Kelly, there are certain indications that should govern you in this matter. Beginning on the inlet or admission valve, a leak can usually be detected by placing your ear to the admission nipple. If there is a worn or scored

Next week Egan will take up the construction and action of fuel valves of various forms and he will point out how to care for such valves

inlet-valve seat you'll hear a whistling sound that will grow louder as the leak grows larger. If you neglect it, the leak will get so bad that you will lose your compression. If the cam is not timed correctly and the valve fails to seat at the proper time, the air will blow back through the admission opening with considerable force.

"Now you see that is simple. But when you come to the exhaust valve, a leak is harder to locate. If you feel suspicious, stop the engine and bar it over until it is in the position where both the inlet and exhaust valves should be closed. Then crack your air valve, and, if the valve leaks, the air will blow out through the exhaust pipe. In order to make certain, the exhaust pipe should

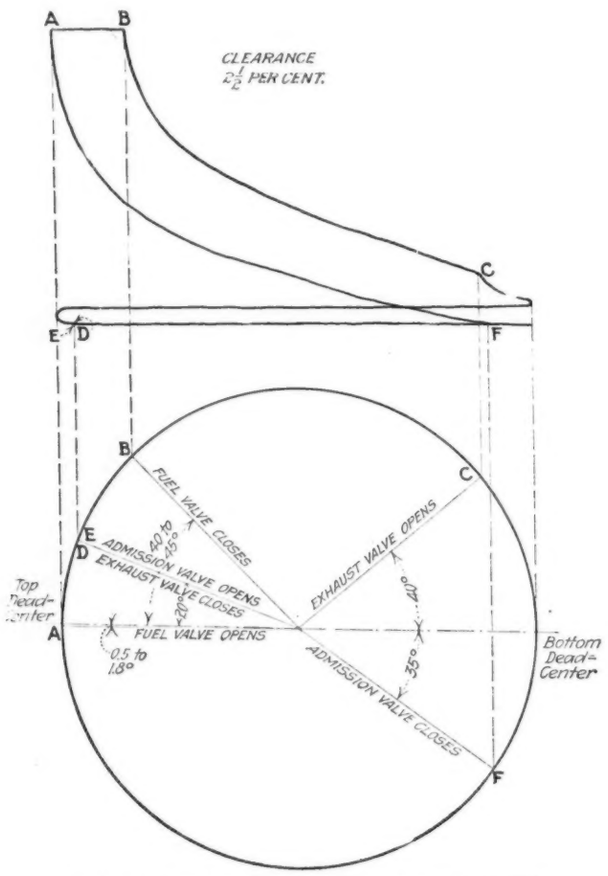


FIG. 2. TIMING OF VALVES AS SUGGESTED

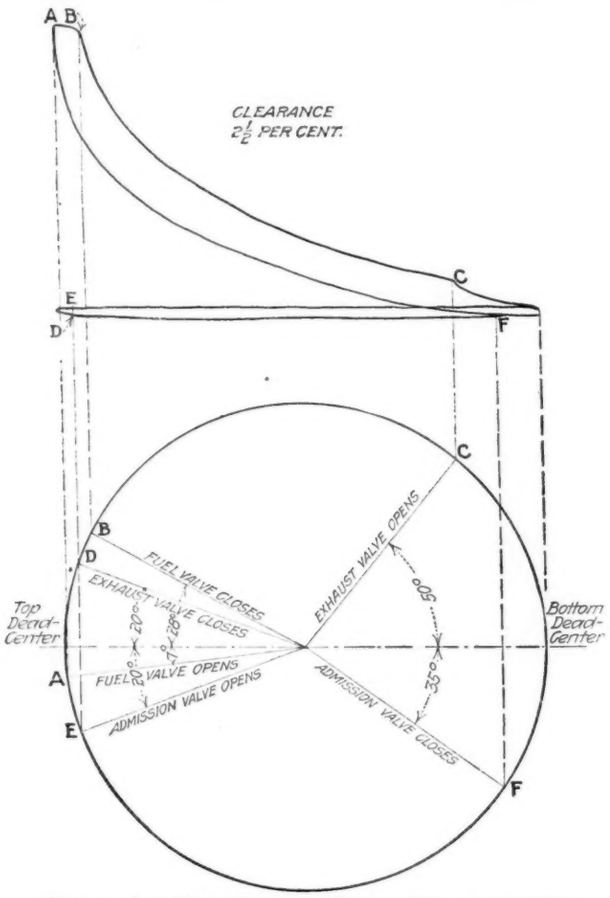


FIG. 3. TIMING OF VALVES AS ACTUALLY USED

be tapped for a ¾-in. cock close to the exhaust opening. Do you get that?"

Kelly nodded, and Egan resumed the discussion with renewed earnestness.

"In my opinion the thing that requires the closest attention is the proper clearance between the valve rocker arm and the cam. Of course, this will vary a little in different engines. In the absence of definite instructions from the builder, a safe value is from 0.02 to 0.04 in. This will take care of any expansion of the valve stem due to heat and at the same time is small enough that no hammer blow is delivered by the cam as it strikes the rocker roller."

"How about timing the valves?" Kelly asked.

"In the setting of the points of opening and closure of the valves you will find considerable differences in the values suggested by different builders. One company gives no data on its engines beyond the original setting at the time of erection. In such cases all an engineer can do is to check the values and make a note of them so that in the future the valves can be kept to the original settings.

"It's of little use to take values given in technical articles. These usually are the values that are correct from a theoretical standpoint and take no account of the fact that the valves do not open and close instantaneously. Recently, I ran across a volume on Diesel engines that contained a lot of valuable information, but when the author began to talk of valve timing, he lost his bearings. For example, here are the settings he recommends: Fuel valve opens 0.5 to 1.8 deg. before top dead-center and closes 40 to 45 deg. after top dead-center; exhaust valve opens 40 deg. before bottom dead-center and closes 20 deg. after top dead-center; admission valve opens 20 deg. after top dead-center and closes 35 deg. after bottom dead-center.

"'Compare these values with the settings we use on the three makes of engines we have here: Fuel valve opens 7 deg. before top dead-center and closes 28 deg. after top dead-center; exhaust valve opens 50 deg. before bottom dead-center and closes 20 deg. after top dead-center; admission valve opens 20 deg. before top dead-center and closes 35 deg. after bottom dead-center. The diagrams shown in Figs. 2 and 3 are based on the foregoing theoretical and practical values, respectively. You can see the difference very plainly.

"The valve settings used on the Busch-Sulzer engine are given in the table. All the values are in inches,

and are measured on the flywheel, on the circumference of a circle 108 in. in diameter. If you convert them into degrees, you'll find they agree pretty well with those I've just given for our engines."

"But, chief," Woods ventured, "why do you say that theory and practice don't agree? I am not well up on that stuff, but I always thought theory and practice had to agree."

"Maybe I did speak hastily," Egan confessed. "What I should have said is that the theoretical and the practical values are different because they are based on different conditions. Take the theoretical values, for instance. You see the fuel valve opens 1.8 deg. ahead of top dead-center while in practice we have it open 7 deg. ahead. This late opening is based, I presume, on the use of a light oil that will atomize and burn instantaneously on entering the cylinder. In this case it is not necessary to open the fuel valve early. In our case we use a fairly heavy oil that doesn't atomize easily, and so it's necessary to open the fuel valve early.

"The theoretical point of fuel-valve closure is too late and all the fuel would not be burned in the cylinder. This is based on the assumption that the fuel charge is being injected into the cylinder during the entire time the fuel valve is open. Actually, the fuel charge has been atomized long before the valve closes, and all that enters through the fuel valve during the latter part of its opening is highly compressed air. This air would tend to increase the pressure in the cylinder, and the indicator card would show an increased indicated horsepower. But it takes power to compress this excess air used, and as a result the net brake horsepower is decreased with lengthening the period of fuel-valve opening beyond what is actually required.

VALVE SETTINGS USED ON BUSCH-SULZER DIESEL ENGINE OF 500 HP., AT 200 R.P.M.

	Number of Cylinder			
	1	2	3	4
Fuel valve opens before top center	7⅝–9	8¼–8¾	8–8¼	8¼–8
Fuel valve closes after top center	28½–16	30–17½	30–17½	31½–18½
Clearance between roller and cam	0.004	0.004	0.004	0.004
Starting valve opens after top center	.....	4	4	.....
Starting valve closes after top center	.....	60¼	61	.....
Clearance between roller and cam	.....	0.012	0.012	.....
Admission valve opens before top center	22	24½	22¼	23½
Admission valve closes after bottom center	37½	41	40½	41
Clearance between roller and cam	0.012	0.012	0.012	0.012
Exhaust valve opens before bottom center	61½	61½	61	60¼
Exhaust valve closes after top center	21½	20¼	20½	22½
Clearance between roller and cam	0.02	0.02	0.02	0.02
Delivery of fuel pump (governor in central position)	7/16	7/16	7/16	7/16

"Turning to the admission-valve operation, the theoretical table recommends that the valve open 20 deg. after top dead-center, while we usually have it open 20 deg. before top dead-center. If the valve delays opening until the piston starts to return on its suction stroke, surely part of the burnt gases in the exhaust piping will be drawn back into the cylinder. Then the pure-air capacity of the cylinder will be reduced 20 per cent. This will also show up in the indicator card by causing the suction line to drop farther below the atmospheric line than it does when using our setting. Of course, this decreases the horsepower."

"Chief," Woods broke in, "is it a good thing to have the exhaust valve open so early? From what I can learn of steam engines, early release is bad."

"It would be very desirable to have the expansion line continue until the pressure in the cylinder equaled the atmospheric pressure, but this would cause too large a cylinder for the horsepower developed, thus making first cost excessive. I will admit that it would be practical to have the release occur later than is customary. This cannot be obtained as long as the builders make the exhaust valve so small. As it is, it is necessary to open early in order to free the cylinder of excessive back pressure."

Egan consulted his watch, and then pushed back his chair. "Well, boys, it's bedtime. When we get to fuel valves, we can discuss any other ideas about valve setting that may occur to you."

Refrigerating Installations in 1918

The record for the year 1918, as compared with 1917, shows a considerable decrease in the number of installations, and the total regrigerating capacity, according to *Ice and Refrigeration*. Reference to the table herewith shows that 979 installations, with a refrigerating capacity of 24,621 tons, were made during 1918, as compared to 1656 installations with a capacity of 39,738 tons for the year previous. The greatest decline is under the head of ice making. This, however, is largely accounted for by the Government embargo placed upon all building operations with the exception of those considered absolutely requisite; the high cost of all materials has also delayed construction.

The large installations made during the year were mainly in connection with the various camps, cantonments and naval establishments. The Du Pont Powder Co., of Wilmington, Del., added to its buildings what is reputed to be the largest refrigerating plant ever installed in a munition works, the total capacity being 3250 tons. The necessity of refrigeration in chemical manufactures, many of which were devoted almost entirely to war work, is evidenced by the number of installations made in such plants.

The certainty of adoption by the country of the prohibition amendment to the constitution is doubtless the explanation of the decline under the head of breweries.

Under the classification of miscellaneous are a number of installations in gas plants, engineering works, church buildings, state institutions, commissaries and others. That the value of refrigeration on ship board is recognized will be noted by the total of 31 vessels equipped with refrigerating machines. The United Fruit Co. of New Jersey installed plants on quite a number of its boats.

LIST OF NEW INSTALLATIONS IN 1917 AND 1918

	1918		1917	
	Installations	Tons Refrig.	Installations	Tons Refrig.
Apartment houses	...	...	3	14
Bakeries	20	193	22	317
Breweries	10	415	15	1,057
Chemical works	27	1,630	20	811
Clubs	14	122	7	25
Cold-storage warehouses	68	3,067	74	3,379
Confectioners	32	446	38	367
Creameries, dairies and condenseries	115	1,488	250	3,006
Department stores	8	33	4	36
Fish dealers	10	67	7	118
Grocers and general stores	22	119	49	184
Hospitals	43	265	49	288
Hotels	27	397	48	645
Ice cream	61	1,544	118	2,382
Ice making	89	3,383	264	16,404
Meat markets	97	625	234	956
Munitions	4	6,450	....	.....
Office buildings	19	95	10	94
Packing house	34	1,563	73	5,411
Produce merchants	23	305	48	428
Provisions and meat storage	52	221	33	436
Railroad depots	5	211	2	56
Residences	11	20	13	26
Restaurants	32	88	34	125
Schools and colleges	7	26	15	71
Shipping	31	185	....	.....
Miscellaneous	118	1,663	226	3,10.
Total	979	24,621	1,656	24,621

How Interpoles Affect the Operation of Direct-Current Machines

By R. L. WITHAM
Assistant Engineer, Sperry Gyroscope Co., Brooklyn, N. Y.

The influence of interpoles on the voltage of generators, the speed of motors and how the effects of the interpoles may be adjusted to obtain the best results are considered.

FROM the article, "Effect of Interpoles on Commutation of Direct-Current Machines," in the Mar. 4 issue, it may be inferred that improvement of commutation is the primary reason for the use of commutating poles, and this is quite true, but it is by no means the only way in which the operation of the machine is affected by their use. Interpoles have an influence on the voltage characteristics of generators and the speed characteristics of motors as well as on the efficiency, weight and cost of the machine. In a generator without interpoles the brushes have to be advanced in the direction of rotation to secure the best commutation at full load, but in the interpole generator they should be kept in the neutral position regardless of the load. This neutral position should be determined before the generator leaves the manufacturer, and the construction of the machine should be such that it is difficult to set the brushes in any other position. If, from any cause, the brushes should get off the neutral position, the effect upon the operation of the machine is much more marked if the machine has interpoles than if it has not. Just what this effect is can be shown as follows:

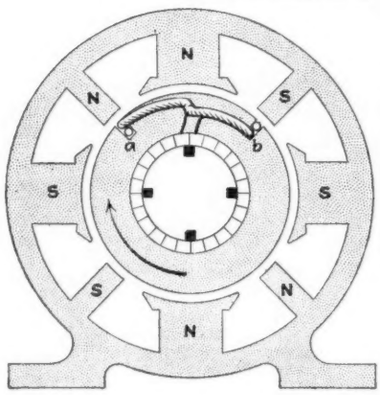


FIG. 1

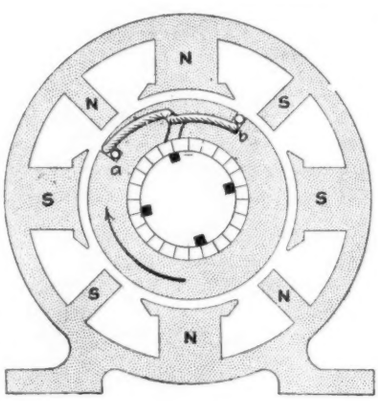


FIG. 2

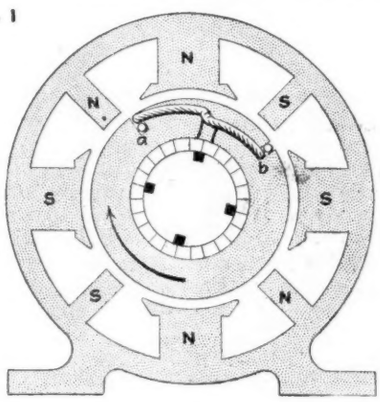


FIG. 3

FIGS. 1 TO 3. SHOWING CORRECT POLARITY OF INTERPOLES AND MAIN POLES FOR A DIRECT-CURRENT GENERATOR

Fig. 1 represents a machine with brushes in the neutral position as is indicated by the short-circuited coil being so located that each of its sides is exactly under the middle of an interpole. If the machine is a generator and the armature rotates in a clockwise direction, the polarity of the interpoles will be as marked in the figure. Now all the conductors on the armature between the points *a* and *b* are cutting the flux from the main pole *N*. If they cut any of the flux from the interpole *N*, they also cut an equal amount of flux from the interpole *S* and these two effects neutralize each other, making the total flux cut, and hence the generated voltage, independent of the strength of interpole winding.

If the brushes of the generator are given a backward lead, placing the short-circuited coil in some such position as shown in Fig. 2, the conductors between *a* and *b* will cut not only all the flux from main pole *N*, but also that from interpole *N* without including any of the opposing flux from interpole *S*. Hence it will be seen that the total flux cut is greater than in Fig. 1 and the voltage generated will consequently be greater. The greater the load on the machine, the greater will be the interpole current and the resulting interpole flux and hence the greater the total flux and the generated voltage. Thus it may be stated that shifting the brushes of an interpole generator backward tends to give the machine a rising voltage characteristic. If the generator is to operate in parallel with other machines, such a characteristic is an objectionable quality. If, now, instead of being shifted backward, the brushes are advanced in the direction of rotation so that the short-circuited coil is thrown into some such position as shown in Fig. 3, it will be seen that the conductors between *a* and *b* cut all the flux from main pole *N* and also that from interpole *S*, and since the effect of the latter is to neutralize a part of the former, the resultant flux cut becomes less the greater the load and the effect of the interpole in this case will be a tendency to give the generator a drooping voltage characteristic. Thus it may be stated that the effect of the interpole of a generator, unless the brushes are exactly in the neutral position, is like that of a series-field winding; a cumulatively connected series if the brushes are moved backward and a differentially connected series if they are shifted forward.

If the machine represented in Figs. 1, 2 and 3 is a motor instead of a generator, its speed will be affected by brush position in a manner similar to that in which the voltage of a generator is affected. In order that

the relative polarity of interpoles and main poles, as indicated in Figs. 1, 2 and 3, may be correct for the case of a motor, the direction of armature rotation must be taken as counterclockwise instead of clockwise as given in Figs. 4, 5 and 6 respectively. Then Fig. 5 represents a motor with brushes given a forward lead and Fig. 6 a motor whose brushes have a backward lead. With a forward lead, as in Fig. 5, the flux cut by the conductors between *a* and *b* is greater than it is when the brushes are on neutral, Fig. 4, hence the speed of armature rotation is less. The greater the load on the motor the greater will be the interpole current and consequently the greater the interpole flux, making the speed decrease with an increase of load. Thus the forward lead of the brushes tends to give the motor a drooping speed characteristic. By a similar line of reasoning it will be seen that shifting the brushes backward, as in Fig. 6, will reduce the flux cut by the armature conductors and will tend to give the motor a rising speed characteristic.

If the interpole field of a motor is too strong or too weak, this condition will also affect the speed of a machine for the reason that the armature coils which are short-circuited by the brush react upon the main field. To explain this more fully consider first that the interpole field is of exactly the correct strength. Then the time of commutation—that is, the time required for a commutator segment to travel the circumferential width of a brush—will be made up of two equal periods; namely, that in which the current is reduced from its normal value to zero, and that in which, after reversal, it is built up again to its normal value.

If the interpole field is too strong, the reducing of the current to zero will take place in less than one-half the entire time of commutation, leaving a proportionally greater time for the building up of the current after reversal. The result will be a preponderance of current in the reversed direction over that in the original direction, and this current may be several times as great as the normal full-load current carried by the same coils when not short-circuited by the brushes. As a result, all the short-circuited armature coils constitute an aggregate of ampere-turns which may reach a considerable value and which, by reason of their location and polarity, directly oppose the main field windings and so reduce the main flux. The result is an increase in speed as the load on the motor increases. This gives rise to the condition known as instability, where the overload and overspeed, each augmenting the other, increase almost instantly to a point which means self-destruction of the motor unless its fuses, circuit-breakers or other similar protective devices operate in time to cut it off from the source of power.

The obvious remedy for such a condition is to reduce the strength of interpole field. This may be accomplished in any one of three ways: (1) By removing one or more turns from the interpole winding; (2) by connecting a suitable resistance in parallel with the interpole winding to shunt out a part of the current; or (3) by increasing the interpole air gap. The first method is open to the objection that it requires the removing of the insulation from the coils and the reinsulating and impregnating after unwinding the desired number of turns. The second method is also undesirable although it is the easiest to carry out. Unless the shunt is so constructed that its resistance and inductance are proportional to the resistance and inductance of the interpole winding, the result will be that on rapidly fluctuating loads the changes in interpole current will not occur simultaneously with the changes in load current and the entire benefit of the interpoles is thereby lost. The third method is usually not difficult of accomplishment since it is customary in building motors to bolt the interpole to the frame and to place between the pole and the frame several thin sheets of iron or steel. By removing one or more of these sheets, the interpole air gap may be increased as required. The weakening of the interpole field must not be carried too far, however, or poor commutation will result therefrom.

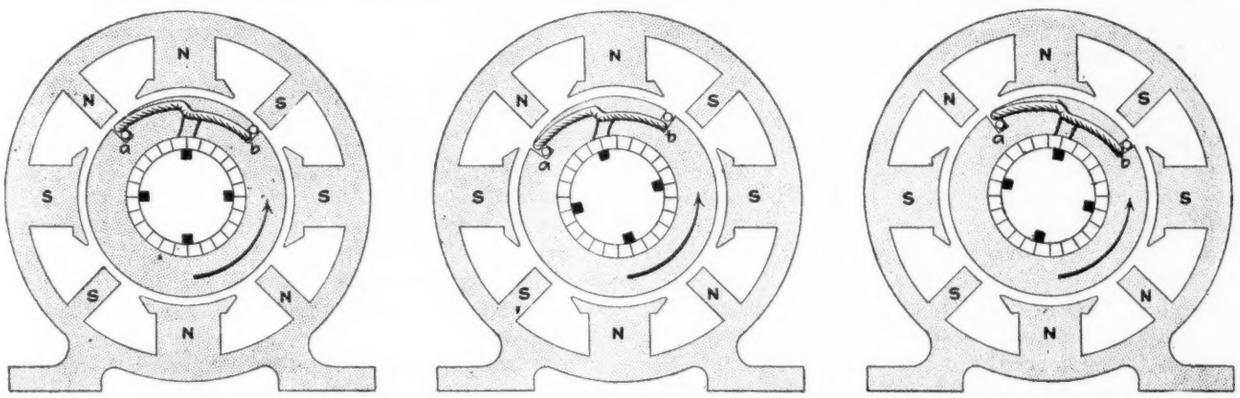


FIG. 4 FIG. 5 FIG. 6

FIGS. 4 TO 6. SHOWING CORRECT POLARITY OF INTERPOLES AND MAIN POLES FOR A MOTOR

When interpoles first came into use, they were often added to noninterpole machines without any change in design other than possibly a different shape of main-field coils in order to accommodate the interpole windings, and these machines were usually of a slightly lower efficiency than the same machines without interpoles. Improvement in commutation or a wider range of speed were the chief objects sought in their introduction, and since the interpole field losses were added to the losses already existing in the machine and the output was not increased, the efficiency was lowered to a small extent. In the modern machines, however, where each part has been designed "from the ground up" with the idea of taking every possible advantage

of the use of commutating poles, such as reducing the length of air gap, the amount of field copper and the magnetic density in the armature teeth, a machine of larger output, smaller losses and consequent increased efficiency has been developed.

It follows, then, that in addition to a marked improvement in commutation over a much greater range of both load and speed than formerly, the use of commutating poles has made possible a machine which will operate at a higher efficiency and can be built with a smaller quantity of material than an old-type noninterpole machine which will do the same work. And in these times when economy of all materials is a vital necessity, the part which the modern interpole motor is playing by replacing its more bulky predecessor is by no means insignificant.

Harrington Forced-Blast Traveling Grate

ATTEMPTS by manufacturers of traveling and chain-grate types of stokers to apply forced blast thereto are in recognition of the widespread demand on the part of power-plant designers for an automatic stoker that can be forced to a point of capacity far in excess of the limits of natural draft. Certain conditions, however, must be complied with before such an application can be considered as commercially successful. These may be briefly summarized as follows:

1. The stoker must allow the fuel to remain quiet during the combustion period, in order to avoid the formation of clinkers that would cause disturbance of the fuel bed when the ash content is in a plastic condition.

2. To avoid the accumulation of refuse in the furnace and consequent fouling of the grate surface, it must be discharged as formed, so that the ash remaining on any unit section of the grate surface is that which results from the burning of a single unit of fuel.

3. There must be no air spaces that are not periodically cleaned by virtue of the automatic operation of the adjacent parts and disengagements of any clinker that may have entered the air spaces during its previous passage through the furnace.

4. Inasmuch as the fuel bed does not require the same volume or pressure of air throughout its extent, it is desirable that the stoker be divided into compartments in such a manner that the air pressure and volume in each compartment are suited to the requirements of the fuel passing over the compartment.

5. The stoker must be readily convertible to the natural-draft type during the low-load periods.

6. Parts subjected to the heat and fusing action of direct fuel contact must be readily replaceable and subjected to no mechanical stress other than its own support and the support of its portion of the fuel bed.

Bearing in mind the foregoing principles, Joseph Harrington, of the James A. Brady Foundry Co., of Chicago, has developed such a stoker, which is shown in the accompanying illustrations.

The stoker consists of cast-iron side frames, carrying the driving gear, hopper front shaft and feed gate in the usual manner. The side girders are formed of structural-steel members, built like a truss, permitting stokers 20 ft. in length to be built. Transverse members of structural steel support a series of tracks, on which run semi-steel chains, which carry and support the grate surface and take up the stress and tension of the chain. These are provided with V-rollers to insure alignment both horizontally and vertically, and

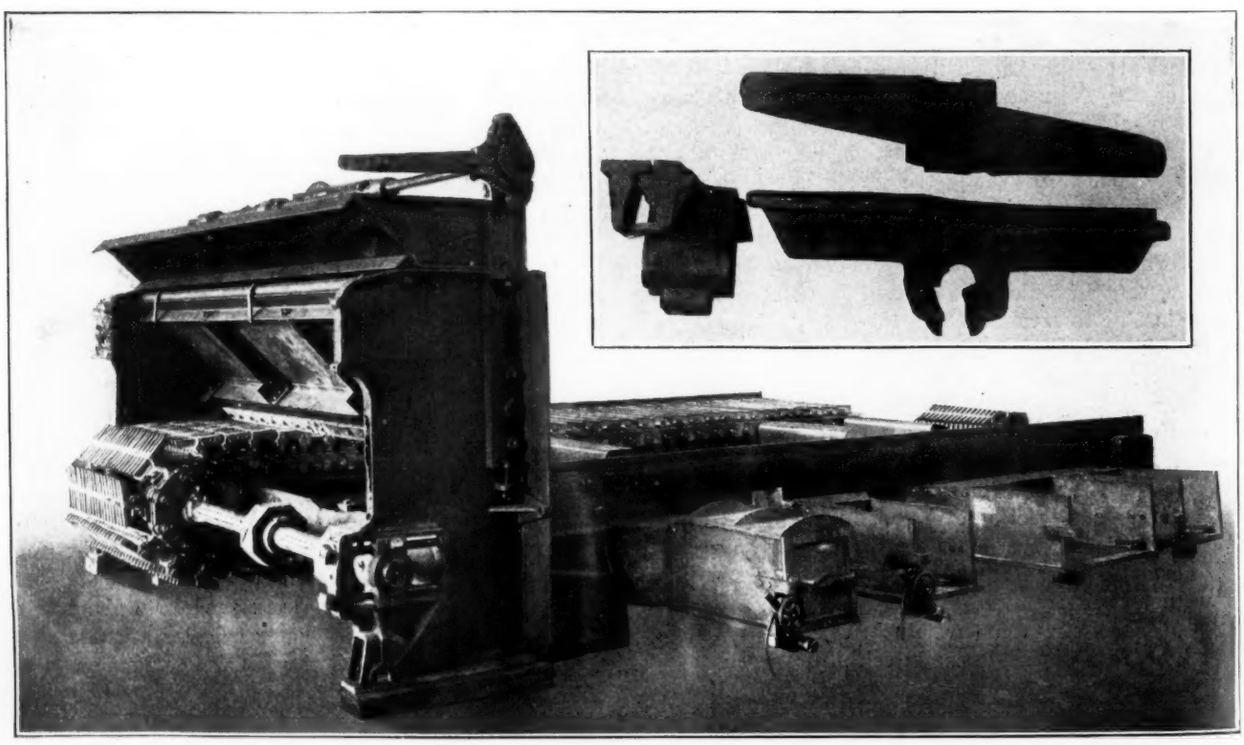


FIG. 1. STOKER PARTLY ASSEMBLED. INSERT, VIEW OF GRATE BARS

to reduce the power required for driving the stoker. An inclosed double worm drive is provided at the rear of the stoker. Attached to the chains is a series of

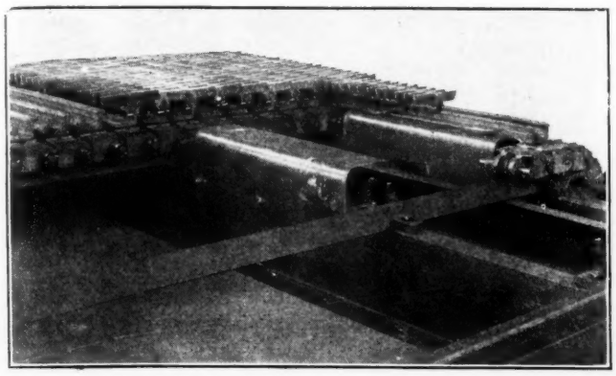


FIG. 2. SHOWING METHOD OF SEALING COMPARTMENTS

transverse racks or beams on which the clips or bars forming the grate surface are attached.

These grate bars are sufficiently loose to slide over the ends of the racks readily. The straight undersurface of these racks makes possible a practically air-tight diaphragm or seal between the adjacent compartments. These compartments occupy the space between the chains communicating on one or both sides to the air duct in the boiler side walls, or below the floor of the boiler room.

A simple form of adjustable damper serves to control the air pressure in the respective compartments. Each communicating passage through the side wall terminates in a removable door which, when taken off, allows free access to the chamber. The closing of the damper and the removal of this door serves to put the stoker on a natural-draft basis. A reversal of this process converts it to a forced-blast stoker.

One of the novel features which will appeal to engineers is the nonsifting grate surface which can be furnished with this stoker when desired. The grate bars so fit together that the air in passing through them makes two right-angle turns, and the lower shoulder at the joint prevents the falling of fuel through the grate. Projections hold the adjacent surfaces apart so that an air space of approximately 15 per cent. is insured.

Fig. 1 is a view of one of these stokers partly assembled. It was designed to burn coke breeze, but the only variation from the standard type is that the grate bars are a little closer together to provide less air space. It has four compartments, the one under the central part of the grate having double the width of any one of the others. The method of sealing the compartments and the general construction are evident in Fig. 2. Underneath the lower run of the grate an extension is built out over the ashpit to protect the bars from radiated heat, and a seal under the rear cross baffle is carried up as close as possible to the moving surface. These provisions obviate the need for a waterback or an overhang to the bridge-wall.

The chambers communicating between the compartments and the common air duct from the fan are shown in Fig. 3. The duct passes immediately below and a common plate damper in the bottom of each chamber controls the volume of air to each compartment. The dampers are operated manually by means of the lever and handwheel shown in the photograph. Each damper can be set in accordance with requirements while the total air supply is controlled through the fan serving the stoker. As previously stated, a

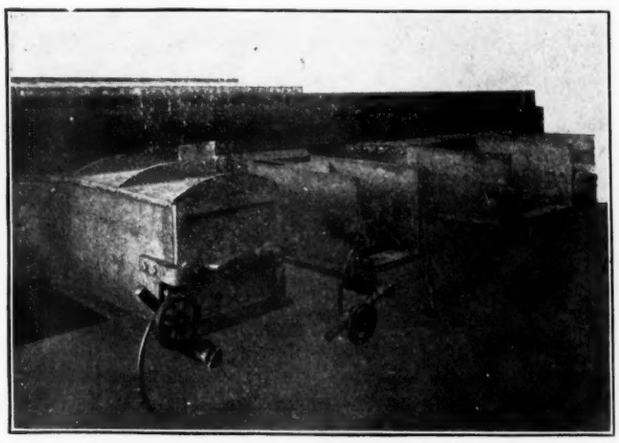


FIG. 3. AIR CHAMBERS BETWEEN COMPARTMENTS AND AIR DUCT

transfer to natural draft is effected easily by closing the damper in each communicating chamber and taking off the end doors.

Coal Production in France

The average output per man per year underground in the Lens coal field of France was about 250 tons, while with us it is more nearly a thousand. The average earnings of a French miner were about $0.90 per day. The Courrières mines cover an area of about 13,000 acres, which is more or less completely underlaid by 40 seams of coal of various thicknesses. These vary from semianthracite to bituminous coal. The mining of these various seams was conducted to a depth of about 1200 ft. The shafts are all connected underground, most of them being hoisting shafts. Their total output was about 2½ million tons annually.

France had a normal coal production of about forty million tons and a consumption of about sixty million tons a year. Seventy per cent., or 28 million tons, was produced in the northern part of France forming a part of the area captured by the Germans. The mines in part of this area have been destroyed. Twenty million tons more coal was consumed than France produced, and the balance was adjusted by coal from England and Germany.

If Alsace and Lorraine go back to France, she will acquire a large active coal territory which is probably undisturbed and a large new and undeveloped territory in Lorraine which has been proved to contain workable coal; but some of it is at a depth of 4000 ft., and it is yet to be determined whether it is possible to mine coal at such a depth. In spite of this France will face a shortage amounting to thirty or forty million tons of coal for the next ten years. Outside of man power, coal will be her greatest need for the next few years, and on her ability to obtain that coal will depend her immediate future progress and recovery. Perhaps the United States can come to her aid.

The Mechanical Equipment of Industrial Buildings—II

By CHARLES L. HUBBARD

In this installment the author considers the selection of type of prime mover, systems of power distribution and methods of heating and ventilating.

IN SELECTING a prime mover, a decision must be made between the engine and the turbine. Turbines, owing to their high speed and uniform efficiency under considerable variations in load, are particularly adapted to the driving of electric generators to which they may be directly connected. They require small foundations and take up little space as compared with reciprocating engines, especially those of slow and moderate speeds. Another advantage is their ability to use highly superheated steam, as no lubricating oil is required in the steam chambers.

The steam consumption of the turbine is, in general, about the same as that of the best reciprocating engine. Tests seem to show that for sizes below 500 hp. the turbine has proved rather more economical when compared with the single-valve high-speed engine, but that results are reversed with the four-valve compound engine of medium speed. For larger sizes, ranging from 1000 to 2000 hp., there seems to be but little difference in the economy of the two types of machines. Under certain conditions engines and turbines can be used to advantage in combination, as described later. In any case, the selection of a prime mover will depend largely on the proportion of exhaust steam that can be utilized when the entire season is taken into account. If this proportion is large, there is no object in putting in an expensive machine for the sake of steam economy, and simple high-speed engines will answer all purposes. As the amount of exhaust that may be utilized becomes less, means should be taken to reduce the steam consumption for power. The first step in this direction is the substitution of the moderate-speed four-valve engine for the high-speed single-valve type. If still greater saving in steam is desired, a reduction of 15 to 20 per cent. may be secured by the use of a compound engine when running noncondensing.

Determining When To Use Condenser

The matter of condensing is one which should receive careful study. With a manufacturing plant, where the exhaust is used for heating purposes, there is no opportunity for using a condenser to advantage except temporarily during the nonheating season. In some cases, however, when the heating season is short and the plant is near a stream or pond where plenty of cooling water may be had for the pumping, this arrangement may prove a good investment. Under suitable conditions a reduction in steam consumption of from 25 to 30 per cent. may be realized by using a compound condensing engine in place of the simple noncondensing type.

Although turbines are frequently operated noncondensing in isolated plants, the best economy is obtained by the use of a condenser. Under these conditions a bleeder turbine may be employed. This type is especially advantageous where large volumes of steam at reduced pressure are needed for heating or manufacturing purposes. It is similar in construction to the high-pressure turbine, but is so designed that steam may be drawn from an intermediate stage after having performed work in passing through the high-pressure stages. It may be set to deliver steam into the heating system at any desired pressure within its range and operates automatically according to the volume of steam required.

Low-Pressure Turbine Using Exhaust Steam

An arrangement that may sometimes be used to advantage in large plants is a combination of a reciprocating engine and a low-pressure turbine, so arranged that the exhaust from the engine runs the turbine. In general, the steam economy of a simple engine and an exhaust-steam turbine together is always an improvement over that obtained by compounding and adding a condenser. The plant capacity is increased from 50 to 100 per cent. by exhausting through an exhaust turbine to a condenser from a noncondensing engine, while the increase by adding the turbine to a condensing outfit is from one and one-half to three times that which could be secured from the condenser alone. Arrangements of this kind, of course, cannot provide exhaust steam for heating and should only be considered as a substitute for the ordinary condensing plant under the conditions already noted.

New types of engines that have shown high steam economy are the uniflow, poppet-valve, and locomobile units. The first of these effects its principal saving by a reduction of the initial cylinder condensation. It operates most economically at a high initial pressure and costs approximately 30 per cent. more than a Corliss engine of the same capacity. The poppet valve is employed primarily to allow the use of superheated steam at high pressures. This engine also gives the best results when operated under a high initial pressure and costs about the same as the Corliss engine. The locomobile is a self-contained power plant, comprising boiler, superheater, reheater, compound condensing engine, condenser, soot blower, and feed-water heater. Its main advantage is its compactness, although the guaranteed fuel economy is exceptionally low.

Use of Producer-Gas and Oil Engines

Producer-gas and oil engines have not been used extensively for this class of work in the United States. While power may be produced at low cost with a producer-gas plant, it requires skilled attention, and lack of this has given it a reputation, to some extent, for unreliability which has limited its use in connection with large and important manufacturing plants where a shutdown for even a short time would be a costly

matter. Oil engines may be operated at a comparatively low cost, especially when located conveniently to the oil regions. They are compact and occupy less floor space than the steam engine of equal power. On the other hand, the cost of an oil-engine plant, is somewhat more than that of a steam plant, especially when there is considered the tendency to install more reserve power on account of the lack of overload capacity and also to provide against more frequent adjustments and repairs. Neither the gas engine nor the oil engine provides exhaust steam for heating purposes, so that a boiler plant must be furnished anyway, and this is an important factor in the selection of the power equipment.

Methods of Power Transmission in Manufacturing Plants

Of equal importance with power generation is its transmission to the various machines, for nothing is to be gained by installing expensive equipment for the economical generation of power and then wasting it in useless work in the form of friction. The different forms of power distribution in common use in manufacturing plants are included under the heads of mechanical and electrical transmission, each having its advantages under certain conditions. Mechanical transmission, which is the older method, has been greatly improved since the advent of electricity for this purpose, so that in certain cases power may be transmitted with equal or even higher efficiency than by the newer method. In making a selection, however, the actual conditions should be carefully studied and the system used which seems to fulfill the greatest number of requirements. Often a combination of electrical and mechanical distribution will prove more effective than either alone.

The improvements in mechanical transmission of power comprise lighter shafting running at higher speed; the substitution of wooden pulleys for iron, which not only reduces the weight but increases belt efficiency; the use of solid flanged couplings, with split pulleys and clutches so that shifting and replacements may be made without disturbing the alignment of the shafting; improved hangers with accurately finished bearings and automatic lubrication; and, of especial importance, the use of the rope drive for long-distance transmission in place of line-shafting. With these improvements it is claimed that power may be transmitted from source to machine with a total efficiency of approximately 80 per cent., divided about as follows: Rope drive, 96 per cent.; lineshaft, 85 per cent.; machine belt, 98 per cent.

Methods of Electric Distribution

Electric distribution is divided into group drive and individual drive. In the former case, electric energy is carried from the generator to a number of motors, which in turn drive lineshafts of varying lengths according to local conditions. From these power is delivered to the machines through belting, either by the use of countershafts or directly from the line as most convenient. In the case of individual drive each machine has its own motor connected by either belt or gearing and is, therefore, entirely independent. Among the principal advantages claimed for this method are the following: Elimination of lineshafting and countershafting, which must run continuously whether the machines are in use or not—an important item in shops where a certain proportion of the machinery is in operation only a part of the time; increased production, due to better speed control of individual machines; uniform speed under continuous operation, there being no fluctuation in speed of the lineshafting due to varying the number of machines in use at one time; a better arrangement of machinery for rapid production, and elimination of useless handling of stock, as machines may be placed without reference to lines of shafting; clear ceiling space, permitting the free use of cranes and hoists and improving both artificial and natural lighting; independence of each machine, there being no interference from accident to lineshafting or other machinery; greater cleanliness and better opportunity for the application of safety devices, and reduction of fire risk through the elimination of oily lineshaft bearings.

The principal disadvantage of the individual electric drive is the decrease in efficiency as the size of the motor is reduced; hence, this system makes its best showing in manufacturing establishments where fairly large amounts of power are to be transmitted. While motors of 75 to 100 hp. have average efficiencies ranging from 92 to 93 per cent., those of 5 hp. and less, such as are used largely for individual drive in a majority of cases, will have efficiencies running below 80 per cent. Some engineers consider 10 hp. as the economical limit for individual drive, and machines requiring less than this are grouped together and operated by motors of sufficient size to give a good efficiency, the power being transmitted to the various units by belting to lineshafts driven by the motors. This, however, applies to general cases, and there are many special instances in which it is advisable to use the individual drive for much smaller capacities.

Selection of Electric Motors

The selection of motors for industrial purposes is a matter of much importance and except for briefest mention is beyond the scope of the present article. All direct-current and alternating-current motors may be divided into three general groups—constant-speed motors, adjustable-speed motors and variable-speed motors. The first group is divided into direct-current shunt-wound motors, alternating-current squirrel-cage motors, alternating-current synchronous motors and alternating-current slip-ring motors.

The direct-current shunt-wound and alternating-current squirrel-cage motors are adapted to equipment requiring a low starting torque and practically constant speed, such as lineshafting, belted machines, constant-speed ventilating fans and centrifugal pumps. When employed in textile mills or woodworking plants where the air is filled with an inflammable dust, the squirrel-cage induction motor should be used, if alternating current is available, because, owing to its construction, there is no chance for sparking. If it is necessary to use the direct-current machine, it must be well inclosed.

The synchronous motor is commonly used in medium and large sizes and is well adapted to drives with light starting characteristics. The slip-ring induction motor

is adapted to equipment requiring a heavy starting torque and constant speed, such as grinders and beaters in paper mills, ice machines, wood planers, brick machinery, etc. When alternating current is not available for this class of work the direct-current compound-wound machine should be used.

The second class, or adjustable-speed motor, includes the shunt-wound, compound-wound and multivoltage machines for direct current, and the multispeed induction motor for alternating current. The first of these is the most flexible and gives the most satisfactory speed control and the greatest steadiness of adjustment. It is especially adapted for the individual drive of machine tools and similar work where adjusted speeds are desired regardless of the load. When conditions are such that a heavy starting torque must be overcome, the compound-wound machine is called for. The multivoltage motor is not so extensively used as those previously described, the expense of more than two supply voltages making it prohibitive for general use. The multispeed alternating-current motor is of the squirrel-cage induction type and the change in speed is obtained by varying the number of poles. This machine is usually limited to four speeds and is employed largely for driving centrifugal pumps, ventilating fans, ice machines and similar apparatus.

Types of Variable-Speed Motors

The third class, variable-speed machines, includes the series-wound motor and the compound-wound with light shunt field for direct current, and the slip-ring motor and squirrel-cage induction motor for alternating current. The speed of any of these machines varies with the load, being high at light loads and decreasing as the load increases. The direct-current series motor has a high starting torque that gradually decreases as the motor comes up to speed. This machine is used for operating cranes, hoists, elevators, and other equipment calling for this special requirement. The compound-wound motor with light shunt field has similar characteristics, making it especially adapted to the operation of elevators where the starting load is heavy and the acceleration high and gradual. It is also used for driving punches and shears, sugar centrifugals and laundry extractors. The slip-ring alternating-current motor has characteristics similar to those of the series-wound machine for direct current and has a similar field of operation, which includes the driving of hoisting machinery of various kinds, dredges, steel mills, etc. The squirrel-cage motor is similar to the slip-ring type except for the fact that the resistance is fixed and cannot be varied; hence, the speed necessarily decreases as the load increases. This motor is particularly adapted to conditions where peaks of short or long duration occur periodically in a cycle of operation and where flywheels are employed to carry the load over these points. Shears, punches, hoists and reversing roll trains in steel mills are included in the field of this type of motor. Much depends on the proper selection of a motor for the particular work to be done, and when electric drive is to be used in a manufacturing plant great care should be given to this part of the equipment.

The heating and the ventilating of the building are so closely connected that they will be considered under the same heading. For industrial plants of large size there are three standard systems of heating—direct steam, direct hot water and hot blast. As compared with hot-blast heating, both direct steam and hot water have many of the same characteristics and may be considered together. As in case of many other kinds of equipment for a large plant, one particular system is not always best adapted to all buildings or all rooms, and a combination will often be found the most desirable when the entire plant is under consideration.

Objections to Direct Heating

The more common objections to direct heating for large shops and factory buildings are the large amount of radiating surface required, difficulty of temperature control and lack of ventilation. The first of these applies especially to large machine and erecting shops of considerable height, either with or without galleries, and provided with monitor roofs. In buildings of this kind the heated air naturally rises to the roof space, which produces a comparatively high temperature at this point and thus increases the rate of transmission through the roof. To overcome this it is necessary to provide heavy banks of heating surface near the floor along the outer walls, which in turn are liable to make it uncomfortably warm for those working near them. This condition may be relieved to some extent by placing a part of the coils overhead, but even with this arrangement the distribution of heat is uneven and roof transmission excessively large.

In buildings of several stories, of medium height, the distribution is better and the excess of warm air rising from the lower stories is often sufficient to take care of the roof transmission without providing extra surface for this particular purpose. In connection with a large plant there are often buildings and rooms where direct heating will answer all purposes and will be even better in some cases than the more expensive fan system. This applies especially to storerooms, packing rooms, carpenter and pattern shops, paint shops, etc., where the cubic space is large for the number of occupants. In rooms where there are disagreeable odors from chemicals or paints, the heating system should be supplemented by an electrically driven exhaust fan.

Hot-Blast System of Heating

For the main workrooms of shops and factories, especially those of considerable height and where the number of occupants is large in proportion to the cubic contents, the best results are secured by the hot-blast system. This gives an even distribution of heat, as the warm air may be directed to the points where it is most needed. In the case of one-story shops and foundries of the monitor-roof type the air may be discharged downward and at an angle toward the outer walls, thus maintaining a zone of warm air near the floor regardless of the temperature conditions in the upper part of the building. By drawing all, or even a part, of the air supply from outdoors, ventilation and heating may be combined without additional equipment.

As the latest theory of ventilation is based largely on the control of temperature and humidity, combined with air movement, it is a simple matter to combine all of these in a hot-blast system by introducing an air washer for the removal of dust and odors due to va-

rious manufacturing processes. With such equipment satisfactory results may be obtained in the average case by recirculating the air within the building, especially in the coldest weather, when the steam demands for both heating and ventilation are at a maximum. An arrangement that has given good satisfacton under actual working conditions has been to design the apparatus for recirculation within the building in zero weather and to admit fresh air in increasing amounts as the outside temperature rises. While special mention has been made of one-story buildings of the monitor-roof type, the hot-blast system is equally well adapted to buildings several stories in height by a proper design of the warm-air distribution system. In the case of foundry buildings, both supply and exhaust fans should be used for removing the vapor present when castings are being made.

As the heating system in a manufacturing plant is likely to be extended horizontally, the most satisfactory results are secured by a return-line vacuum system when direct steam is employed. This not only insures a positive return of the condensation without water-hammer, but also accelerates the circulation and makes it possible to operate the heating system without throwing additional back pressure on the engines. If hot water is used, it must always be under forced circulation in plants of this kind. This system of heating has proved very satisfactory in many cases on account of the ease with which the temperature of the buildings is controlled. All three of the systems mentioned use either live or exhaust steam, as most convenient, so there is no difference between them on this score. A selection is usually based on the general layout of the plant, the results desired and the funds available.

Eliminating Cylinder Oil from Exhaust Steam

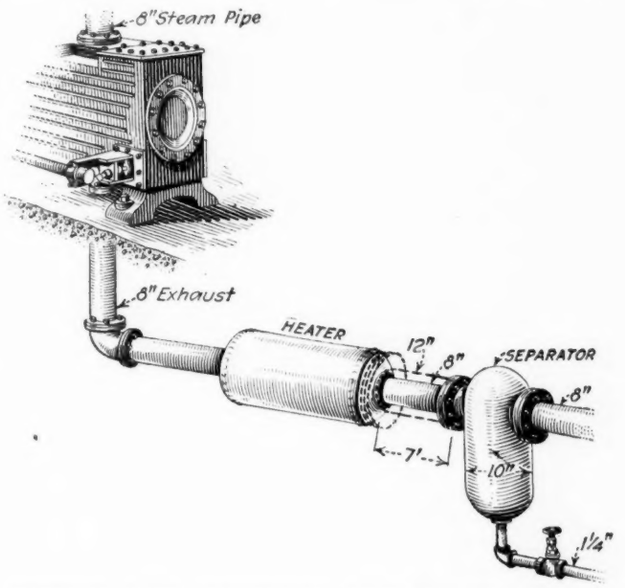
By W. H. Wakeman

In a certain manufacturing plant where a large portion of the shop is heated by the exhaust of the engine, the resulting hot water was allowed to flow into the sewer without the use of traps to prevent the escape of steam. As a measure of economy it was decided to return this hot water to the boilers, but this involved the use of a separator to free the condensate from oil. An 8-in. separator was accordingly installed, the maximum load on the engine being some 300 hp. The arrangement was as shown in the accompanying sketch. There was no trap on the 1¼-in. drip pipe. The engineer kept the valve partly closed, but it was always opened far enough to allow all the oil and water that were taken out by the separator to pass to the sewer. After the separator was installed, all hot-water returns from the heating system were pumped back into the boilers.

Subsequent boiler inspections showed that an objectionable quantity of cylinder oil was passing through the separator and entering the boilers. Suggestions were made to the engineer in charge to the effect that the separator was not properly located, that it was not the right kind for efficient service, that it ought to be taken apart and cleaned frequently, etc., but the boiler inspector insisted that the trouble was due to the fact that the separator was too small for the service required of it.

He maintained that not more than 90 lb. of steam per hour per square inch of pipe area should be forced through a separator. With a maximum load of 300 hp. and assuming 30 lb. of steam per horsepower-hour, an 8-in. separator with a cross-section of 50 sq.in. would pass $300 \times 30 \div 50 = 180$ lb. per hour.

In order to test this rule, the 8-in. separator was removed and a 12-in. of the same kind located in the same position. The 7-ft. length of 8-in. pipe between



SHOWING NEW CONNECTION BETWEEN HEATER AND SEPARATOR

the heater and the separator was taken out and a 12-in. substituted, as shown by the dotted lines. No further changes were made, either in the equipment or in its operation, but the exhaust steam is now purified, so that no oil goes into the boilers; hence the experiment is pronounced a success and the correctness of the inspector's formula demonstrated.

Although moderate additions were made to stocks of petroleum in November, 1918, in the central and north Texas, north Louisiana and Rocky Mountain fields, the total surface reserve of crude oil in the United States, exclusive of California, was reduced during that month by about 3,500,000 bbl. On Nov. 30, 1918, stocks of petroleum in the fields to which this summary relates had been depleted to the extent of about 25,000,000 bbl., compared with the quantity in storage at the end of November, 1917.

The City of San Francisco has built and will operate a steam railroad 65 miles in length in connection with its famous Hetch Hetchy water-supply project. This is believed to be the first steam railway of any considerable extent to be built and operated by a municipality. The cost of the San Francisco railroad complete was approximately $2,000,000, and it is estimated that the city saved between $2,000,000 and $3,000,000 over what it would have cost to haul the material by truck.

When Doctors Disagree—II

By JOHN S. CARPENTER

The engineer of the turbine plant locks horns with the builder's engineers over the question of the proper method of finding the stream flow and proves that the efficiency is below the guarantee.

FLOSSY came up to me after I told him how he fell down on the guaranteed efficiency and asked me where I took my degrees, if I had any. I tells that candy-covered cocktail that I got mine at the University of Hard Knocks, an' as fer degrees, I had about a hundred an' ten of the Fahrenheit variety an' not mentionin' ten or twenty of the Masonic brand. I guess my magnetic personality got him that time, the same bein' from takin' so much iron tonics an' then hangin' around them generators. He writes down a formula about the length of your forearm an' coyly murmurs, 'I suppose that you used this formula?' I looks at it an' snickers: 'What the Samhill's that?' He hands me a kinda queer look an' simpers that that's the latest formula by some Rooshian gent. I tells him, 'I s'pose I'm a bit behind the times, but my honest opinion of that is that it looks like the wedded name of a Rooshian vampire-lady after she married all the

"AN' THEN WE ALL WENT OVER THE TOP WITH FIXED BAYONETS"

consonants in the Chinese alphabet. All Rooshia ever gave us is them Bolshevik fellers an' a lotta worry.'

"Along about that time another engineer comes in with a letter to me, the same readin' to the effect that our president had engaged him as reinforcements fer me, outa the office of a rival turbine company. I kinda liked that feller Johnson from the start, he bein' dressed like a human bein' an' smokin' a man's size cigar. After the introductions I says that we had better come into my office where we can finish the bout in private.

"When that feller Johnson checks over the figures of them two chorus men, it comes out that they kinda careless-like deducted the head due to the velocity of the turbine discharge water from the effective head, makin' about three feet less head on the wheels an' jumpin' the efficiency way up!

"Flossy protested against addin' in the discharge head an' said that they always did that an' that they considers it proper to do so. Johnson kinda sly-like says somethin' about some confidence men still sellin' gold bricks when they could get it across, an' then we all went over the top with fixed bayonets. When the smoke of battle cleared an' we had signed up an armistice, we got down to brass tacks. We agreed to:

"1. Make comparative weir, float an' current-meter tests.

"2. To check the pressure and vacuum gages against a mercury colyum.

"3. To take the wattmeter readin's as correct, seein' that the meters is new an' not likely to be much out.

"4. To take the generator efficiency curve as given by the builders.

"5. To settle all scraps by Marquis of Queensberry rules.

"The next question to decide was whose formula was to be used for the weir tests. If you count 'em careful, Bill, you'll find that they is as many of 'em as they is fake widows comin' to light when a rich bachelor cashes in his chips. Flossy trots out a formula invented by a Dutchman named Biel, as long as a wienerwurst an' havin' a temperature correction, but I tells him that it's outa the question to ring in any propaganda on this job on account of the new law what says we can't give no aid or comfort to the enemy. Johnson overrules me, sayin' that we can use it for comparison anyhow. Then Omar rips out another, the same bein' a second cousin or somethin' to the binomial theorem in the thirty-third degree, but we passes it up on account of the shortage of paper.

"I hollers pretty loud fer the good ol' Francis formula, an' we fin'lly agrees on that with a protest from that feller Johnson askin' me if it never occurred to me that water at 40, 50 an' 60 deg. acts like so many different liquids. I says, 'Sure thing.'

"Without any more doin's we got right to work an' built a light wooden bridge over the tailrace channel, an' marked the floor off in 5-ft. spaces at the edge. Then we put up light scantlin's at these spaces and marked them for every 2 ft. in depth of the channel. Then we took the current meter an' measured the velocity at every one of these points on the scantlin's an' goin' all the way acrost. Flossy made a cross-section of the channel an' connected points of equal velocity. Then we took each rectangle an' multiplied its area by the velocity, an' so on fer the whole cross-section. Addin' all these figgers together, we got the total water quantity; by dividin' the quantity by the total area, we got the alleged true average velocity of the water. But say, Bill, it ain't often that a guy like me ever gets what the sky pilots calls 'stings of conscience.' I could 'a saved the company the mere trifle of $200 by stickin' to my float tests, an' forgettin' that they ever was such a contraption like a current meter. With the current meter we got just about 2 per cent. less water than I did by my careful float tests."

"I heard tella people smokin' Camels, but why ain't the current meter the best an' most accurate way?"

"Bill, they is a lotta people which thinks they ain't nothin' that can touch a current meter, but let me tell you that a current meter is affected by local swirls an' eddies like a float is, an' while you're measurin' at some dinky little place an' takin' the hickey out to another, the conditions of flow may be altered in a wink by a gust of wind comin' along an' speedin' up the flow velocity. The ratin' curve of them critters must change with the kinda temperature it's workin' under, 'cause it's well known that metal works stiffer an' lubricants changes under different temperature conditions."

"But on any particlar job, the temperature is about constant durin' a test, ain't it?" says Bill.

"The devil it is! S'pose you go testin' early in the mornin', fer instance. The turbine is carryin' full load then, an' you work along until the dinner hour comes an' bats you in the slats. Does the temperature change durin' them times if you thinks of makin' a real current-meter test fer say half, three-quarters an' full loads? Besides that, them things has been known to kick over the traces an' change their ratin' without notice. That's why with all them uncertainties, you can't go too much on a current-meter test. That's why it's nice on paper to say we divided the channel off into spaces an' measured the velocity in each place, integratin' the whole an' gettin' the honest-to-goodness true average velocity. Wind, temperature and the pussunal habits of them meters all has to be considered. No, Bill, me fer a float test, but a real float! If the load changes between times, the timin' on that trip will show it. Temperature will not affect the thing, unless it gits froze in. Wind will shove it along or hold it back, but the timin' will show its tricks. When a feller says he made one o' them high-brow tests where they tried to split hairs, you ask him tactful-like if he is sure that none of the conditions changed durin' the test over the whole area of the channel, not even the head on the turbines. You'll see him look at you kinda queer an' ask if you b'lieve in ethics for engineers. As a partin' shot on this subject, let me tell you what Professor Schoder, of Cornell says, talkin' of subsurface floats: 'Careful work will give the discharge within 5 per cent. of the truth.' Now, for current meters, he says, 'Careful observations make it possible to obtain results within 5 per cent.,' if the banks are fairly parallel, etc., referrin' to rough streams; but with canals an' 'all conditions favorable, results within 2 per cent. of truth may be had by experienced observers.' Now, he assumes that nothin' changes during the time of test. The great point that you don't get is that a change in conditions shows up almost right away with a float test, but with a meter test where they measures every little strip of area, you may go on for maybe a half-hour on a big job before a change will show up, an' it's dollars to doughnuts that the change don't show up unless you repeat the test."

"Where did you get that dope that you blame on Professor Schoder? I wanna read it," declared Bill.

"Outa Marks' Mechanical Engineers' Handbook.

"Gittin' back to the story, after bein' all het up by your questions, the weir tests gave us 1½ per cent. less water than the current-meter test did. But after what I saw with those two weirs, I ain't got much confidence in weir tests unless they runs 'em off in still air an' the tests are made about the same time every day, so that the temperature is about the same on all of the tests. Fer, on the weir above the plant, when the wind was blowin', the sheet of water goin' over the weir was thinner than it ought to be accordin' to the formula an' the velocity was greater. We knew darn well that there was more water goin' over than what the formula would show 'cause we had a weir below the plant in a sheltered place, where the wind couldn't reach it, an' by the same formula, altho the weirs were of slightly different proportions, the discharge checked pretty close under similar conditions. Therefore, Bill, whenever you tries to spring a new weir formula on me, you gotta have a

"FLOSSY SAID IT WAS BY THAT DUTCHMAN'S FORMULA'

term in it that's allowin' fer wind or you better tell it to somebody else."

"Did the engineers on that job seem satisfied with the weir tests, comparin' 'em against the meter and float tests?"

"Well, Johnson said that the weir tests always gave them a little higher efficiency on the same runners than when they was run by a meter or float test. The thing what them fellers was all the time wishin' fer was a pitot tube, which, so far as they knew, only had to be calibrated onct an' then it was set for good."

"How much do you think the temperature affected the readin's, an' is it worth while fussin' about?"

"Bill, them fellers had quite satisfied themselves that it didn't make over 1 per cent. in the ranges of temperature that we had to figger with. They didn't tell me just how they got to that idee, but Flossy said it was by that Dutchman's formula. They's another thing I forgot to say when I was rantin' about the current meter an' that is, an' the same applies to the pitot tube as well, that in the calibration of them critters they is towed instead of havin' the current butt against them like they does in actual use. This effect on the instrument is not the same an' is called DuBaut's parrydox. They is another source of error there that is not generally known, an' it's hard to say whether it's 1 per cent. or less.

"All the other points in our tests was settled in a peaceable manner an' without much discussion. The tests came out 78½ per cent. at full load which was rather discouragin' to the candy kids. But they died hard, an' with their boots on, the funeral bein' strictly private an' the announcements sayin' 'Please omit flowers.'"

The Electrical Study Course—Current Distribution in Three-Wire Systems

Takes up the subject of current distribution in the balancer machines and in the lines, for unbalanced conditions on the system, and proceeds to a discussion of the speed regulation of the sets.

IN THE preceding lesson we found that in a system such as that illustrated in Fig. 1 the total energy is obtained from the generator G. Also that when the system is balanced there is no current in N and that $I_1 = I_2$ and $I_A = I_B$, from which $I = I_1 + I_A = I_2 + I_B$. Under these conditions the directions of the currents are those indicated by the arrows. We will suppose that the loads L_1 and L_2 both consist of 100 lamps taking 1 ampere each, and that the current required to run the machines G_1 and G_2 idle is 5 amperes. We would then have $I_A = 100 \times 1 = 100$ amperes, illustrated in Fig. 2. The value of I would be 85 amperes, as just found. The value of I_A would be $100 \times 1 = 100$ amperes, and that of I_B would be $60 \times 1 = 60$ amperes, making $I_N = I_A - I_B = 100 - 60 = 40$ amperes. The directions of these various currents are those indicated by the arrows.

Since I is only 85 amperes and I_A is 100 amperes, it follows that the difference, $I_1 = 15$ amperes, must flow through G_1 in the direction of the arrowheads. On the other hand, I_B is only 60 amperes, whereas I in M_2 is 85 amperes, which means that I_2 must be equal to $85 - 60 = 25$ amperes and must be in the direction of the arrowheads. The net result so far as G_1 and G_2 are concerned is that I_1 has changed from 5 amperes in one direction to 15 amperes in the other; that is, G_1 is acting as a generator delivering 15 amperes to the system, while I_2 has increased from 5 amperes to 25 amperes in the same direction, showing

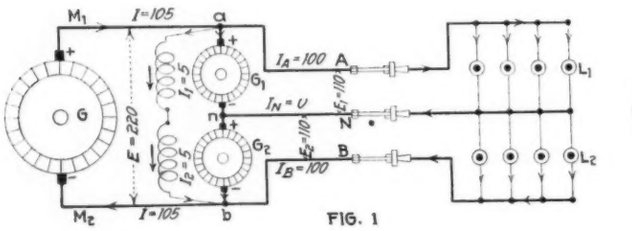


FIG. 1

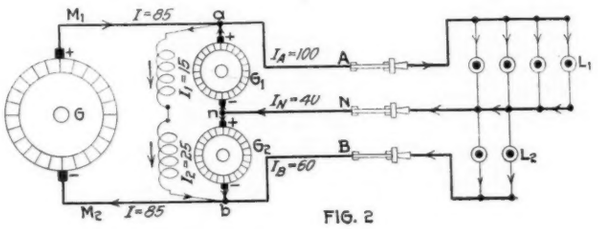


FIG. 2

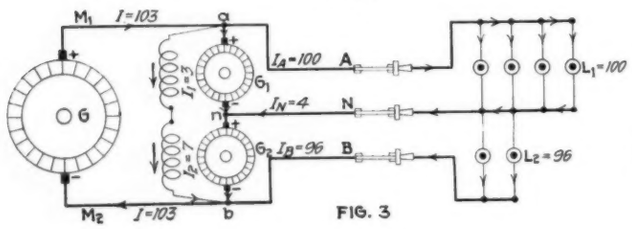


FIG. 3

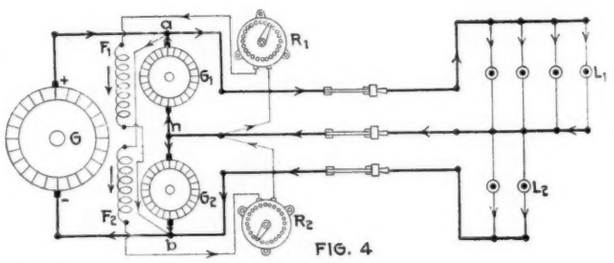


FIG. 4

FIGS. 1 TO 4. SHUNT BALANCER SETS CONNECTED TO A THREE-WIRE LOAD

$I_1 = 5$ amperes, and $I = I_1 + I_A = 5 + 100 = 105$ amperes, as shown in the figure.

The value of I could also be deduced directly from the load upon G. Thus, if the lamps were 110-volt ones, making the voltage across ab 220 volts, we would have as the load upon G twice 100 lamps of 1 ampere each at 110 volts plus the power required to run G_1 and G_2; namely, 5 amperes at 220 volts. That is, the load upon G would be $(2 \times 100 \times 1 \times 110) + (5 \times 220) = 23{,}100$ watts, and the current required of it would be $\frac{23{,}100}{220} = 105$ amperes, as previously found.

Assume now that 40 of the lamps of load L_2 are turned off. The total load upon G will then be 160 lamps plus the machines G_1 and G_2, which will make it $(160 \times 1 \times 110) + (5 \times 220) = 18{,}700$ watts, and the current required of G would be $\frac{18{,}700}{220} = 85$ amperes. The conditions as they would then exist are that G_2 is still running as a motor but under a much heavier load.

The sum of the currents through G_1 and G_2—namely, $I_1 + I_2$—is $15 + 25 = 40$ amperes, which is the value of the current I_N in the neutral wire. It might appear at first thought that this current should divide equally, 20 amperes going through each machine. The following explanation will make clear what happens:

When the load was balanced and the machines G_1 and G_2 were running as motors, they were taking 5 amperes and generating a counter-electromotive force somewhat less than the applied voltage, the latter being equal to 110 volts across each machine. Now, before machine G_1 can become a generator, its voltage must be increased to a value where it will be greater than its applied voltage or the applied voltage decreased a value until it is less than the generated voltage. In this case the latter is brought about by machine G_2 taking an excess current over that of G_1, when the load L_1 is greater than L_2.

First, assume that the load is unbalanced only 10 amperes; that is, I_A is 10 amperes greater than I_B. Then 10 amperes will flow along I_N and through G_2. This 10 amperes through G_2 will cause the voltage to increase between N and B and decrease across A and N, as explained in the preceding lessons. The decrease in voltage between A and N is just sufficient, in this case, to make the applied volts equal the generated volts of G_1, consequently no current is flowing through the armature of G_1. This brings about a condition where the set is taking just the same power from G as when both were running as motors. In the first case we had the two machines G_1 and G_2 taking 5 amperes at 220 volts, or $220 \times 5 = 1100$ watts; in the second case the power is all taken by G_2 at approximately 110 volts and 10 amperes, or $110 \times 10 = 1100$ watts as before.

Now, any further unbalancing of the load will cause the voltage between A and N to decrease below the generated voltage of G_1, and this machine will become a generator and deliver current to the load L_1. Since what the voltage decreases across A and N it must increase across N and B, it follows that after a condition is obtained where all the load has been transferred to G_2, any further unbalancing must divide equally between G_1 and G_2. Assume that the load L_1 is increased 30 amperes; this additional load divides 15 amperes through G_2 which causes the voltage to increase across this side of the circuit and decrease across G_1, so that G_1 becomes a generator delivering 15 amperes to L_1. In other words, 15 amperes flows from G through the additional load on L_1 and along the neutral back through G_2, which unbalances the voltage until G_1 becomes a generator and delivers 15 amperes to L_1. This gives $I_1 = 15$ and $I_2 = 10 + 15 = 25$ amperes.

On one side of the balancer set the power in watts $= EI = 220 \times 85 = 18{,}700$; on the other side the watts $= E_1$ or E_2 times $I_A + I_B = 110 \times (100 + 60) = 17{,}600$, which leaves a difference of 1100 watts not accounted for and at first thought may appear to be a discrepancy. But it has already been shown that G_2 was taking 10 amperes at 110 volts, or 1100 watts, before G_1 began to deliver any current. This represented the power necessary to drive the machines and must be added to the power supplied to the lamps, which gives the total watts delivered by G as $17{,}600 + 1100 = 18{,}700$, which checks up with the value obtained in the foregoing.

If the system is only slightly unbalanced, the current through the machine connected to the more heavily loaded side will not be reversed; it will merely be reduced. For example, if only four lamps were to be turned out in L_2 instead of forty, the conditions would be as follows: The current I_A would be 100 amperes as before, but I_B would be 96 amperes, making $I_N = 100 - 96 = 4$ amperes. This current would flow through G_2, which would throw the voltage out of balance to the extent that machine G_1 would take only 3 amperes from G, which would also flow through G_2. This added to the 4 amperes from N gives 7 amperes in the armature of G_2. In this case both machines would be running as motors, but G_1 would be taking 2 amperes less than the current required to run it idle, so that it would be imposing upon G_2 that much load. The current I in the main M_1 and M_2 would be computed exactly as before. Thus, the total load on G would be 196 lamps of 1 ampere each at 110 volts plus the machines G_1 and G_2, which would give $(196 \times 1 \times 110) + (5 \times 220)$ or $(3 + 7) \times 110 = 22{,}660$ watts or $\frac{22{,}660}{220} = 103$ amperes. Since I_A is only 100 amperes, it follows that 3 amperes must flow through G_1 from a to n, as was shown to be the case. Similarly, I in M_2 is 103 amperes, whereas I_B is only 96 amperes, thus requiring that 7 amperes flow through G_2 from n to b, which was also shown to be the case.

As a matter of fact the currents on unbalanced loads will not be absolutely of the theoretical values if the fields are connected as in Figs. 1, 2 and 3, because the voltage of one side of the system is below normal and that of the other above normal, causing each lamp across the one side to take slightly less current than it should, and each lamp across the other side slightly more than it should, so that the totals of the currents would not be exactly those figured. If, however, the excitation of the machines is accomplished as in Figs. 4 and 5, the voltages across the two sides remain practically constant under all conditions and the actual

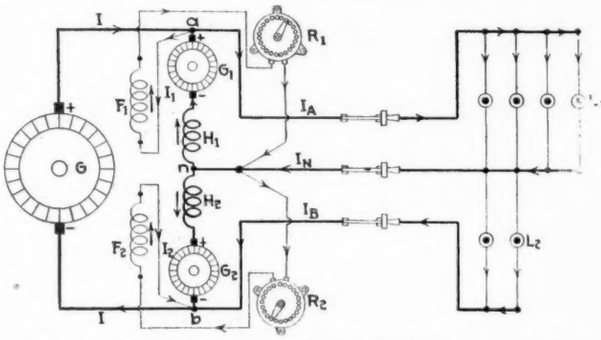


FIG. 5. COMPOUND BALANCER SET CONNECTED TO A THREE-WIRE LOAD

values of current will be very nearly the same as the theoretical. There will always be a small difference due to the fact that as the machines G_1 and G_2 become loaded the losses within them increase and these must be made up by current supplied from G. However, the difference is so slight that it may be ignored in practical computations.

The next subject in order for investigation is the relation between the amount of unbalancing of the system and the speed of the balancer set. We shall consider the relation only in the systems which maintain constant voltage across the two sides; namely, those illustrated in Figs. 4 and 5, since those that do not maintain constant voltages are not in practical use.

Taking the case of Fig. 4, let us suppose that the load L_1 is greater than L_2. Then G_1 will operate as a generator driven by G_2 running as a motor. We know that when a shunt motor is loaded it slows down somewhat in order to reduce its counter-em.f. to the value required by the load. That is, $I_2 = \frac{E_2 - E}{R_a}$, where I_2 is the armature current of G_2, E_2 is the terminal voltage, E the counter-em.f. and R_a the armature resistance, showing that E must decrease if I is to increase. Since E can be decreased only by a reduction in field current or a decrease in speed, it follows that the speed must come down since the field current is constant

so long as the line voltage is constant. However, in the case under consideration the conditions are considerably modified. When G_2 begins to slow down G_1 must slow down with it, which causes its voltage to decrease. Now the voltage across ab is kept constant by the generator G so that if the voltage of G_1 decreases by a certain amount, that of G_2 must increase by the same amount. The decrease in voltage across G_1 would reduce the current through F_2, thus decreasing the excitation of G_2. Combining these effects, we find that at the instant the load is unbalanced the motor G_2 has a load put upon it that tends to slow it down, but it is prevented from doing so by the fact that as soon as it attempts to, the voltage across its armature is increased and the current through its field is decreased. The effect of either of these results is to cause an increase of speed, and their combined effect is such as to prevent any material drop in the speed.

When compound machines are used as in Fig. 5, the conditions are very similar to those that obtain with shunt machines arranged as in Fig. 4. A further discussion of the effect of the series field will be given in the next lesson.

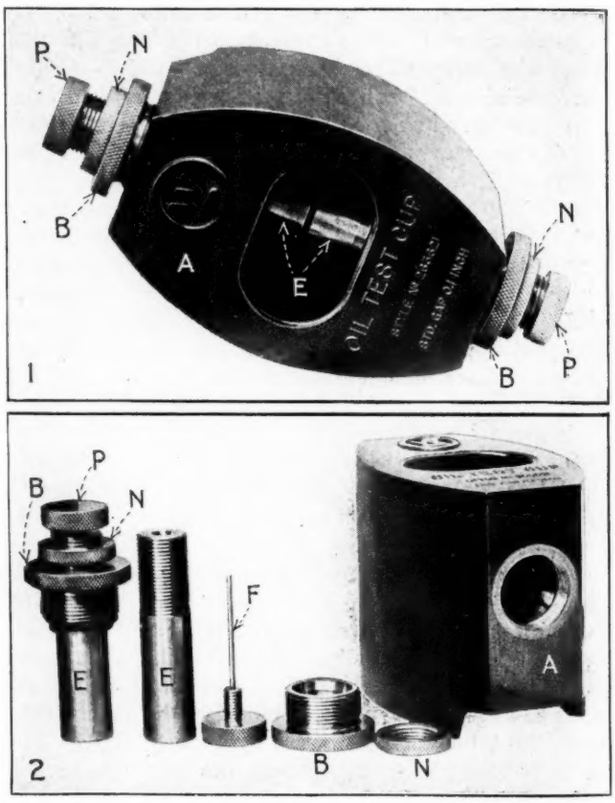
The last problem was to find the size of wire required for the mains from a generator to a balancer set ½ mile away, if the line drop was not to exceed 10 per cent. when the load supplied was one of 100 amperes at 110 volts. If the total current is 100 amperes, each side of the system would have $100 \times \frac{1}{2} = 50$ amperes upon it, and that would be the current in the outside wires. If the maximum permissible line drop is 10 per cent. of the voltage at the generator, we have $E - 0.10E = 220$ volts, where E is the voltage at the generator and 220 volts is the voltage across the outside lines at the balancer. From this $0.90E = 220$, or $E = \frac{220}{0.9} = 244$ volts, and 10 per cent. of E is therefore $0.1 \times 244 = 24.4$ volts. The line drop is the line current multiplied by the line resistance, or IR. Since the current is 50 amperes, we have, $50 \times R = 24.4$, or $R = \frac{24.4}{50} = 0.488$ ohm. The line is ½ mile long, which makes the total length of the two wires $2 \times \frac{1}{2} = 1$ mile, which is equal to 5280 ft. Consequently, the resistance of one foot would be $\frac{0.488}{5280} = 0.0000924$ ohm, and per 1000 ft. we would have $1000 \times 0.0000924 = 0.0924$ ohm. From the wire table we find that a No. 0 wire would be required.

In Fig. 5 the load consists of 100-watt 110-volt lamps. There are 800 in L_1 and 600 in L_2. The machines G_1 and G_2 take 20 amperes when running idle. What values have the currents I, I_A, I_N, I_B, I_1, and I_2, if the generator G maintains a constant voltage of 220 volts across ab?

Insulating-Oil Testing Cup

The only known satisfactory method of determining the insulating value of oil is to measure its dielectric strength by means of a spark gap immersed in the oil. Various devices requiring a comparatively large sample of oil and a rather high voltage for their successful operation have been used for this purpose. Consequently, there has existed a distinct demand for a device that would give reliable indications with a minimum sample of oil and with a relatively low testing voltage. A device for this purpose has been developed by the Westinghouse Electric and Manufacturing Co., and is shown in the figures. Fig. 1 shows the oil tester complete and Fig. 2 the various parts.

This new design uses a molded construction, so that the cup A is one piece. The molded part contains two brass electrode bushings B and is threaded to receive the packing gland. Back of each packing gland is a small amount of cotton packing, such as waste, which prevents oil leakage around the electrodes. The electrodes E are made from a cylinder one inch in diameter, threaded at one end to receive the locknut N. Binding posts P are placed on the outside end of the electrode to attach the leads from the testing transformer. A



FIGS. 1 AND 2. OIL-TESTER ASSEMBLY AND PARTS

steel feeler gage E for setting the gap at exactly 0.1 in. is attached to one of the binding posts. The device has a cup-shaped interior to contain the oil substance to be tested, and the construction allows thorough cleaning without disturbing the gap setting.

The testing cup is light, compact and convenient. It weighs only 6.5 lb., with dimensions of 8.5 x 4 x 4.75 in., and requires only a 4-oz. sample of oil. The maximum voltage required for reliable testing is 25,000 volts. Higher voltages may be used if available, but it is seldom that higher than 30,000 volts will be required to discharge across the standard gap (0.1 in.) through any insulating oil.

Distillation of the oil shales found on White River, Utah, yields an average of 54 gal. of oil per ton.

EDITORIALS

Salvaging the Disabled

PROCEEDING upon the theory that an employer who gives a disabled man a job that is temporary and that requires no skill is not doing the man a favor but an injury, the Federal Board for Vocational Education at Washington has entered upon a program of constructive training which it is hoped will reach a large majority of the disabled soldiers and enable them to do just as effective work as their more fortunate comrades. Without such training to render them independent, there would be the ever-present danger, after the war has passed into history, of their becoming human derelicts.

It is estimated that sixty thousand disabled men will require aid in obtaining employment. Of these approximately thirteen thousand have already been discharged from hospitals and returned to a civilian status, and one of the immediate problems of the Board is to reach them. In the case of those yet to be discharged the problem will be somewhat simpler, as there is now the necessary organization and coöperation with the army to reach them.

Under the plan each man receives while in training sixty-five dollars per month if single and, if having dependents, such additional allotment as is absolutely necessary. Thus the proposition is rendered attractive enough to interest the disabled man; his acceptance being, of course, entirely voluntary. Moreover, in directing the training, efforts are being made to conserve, as far as possible, the man's pre-war knowledge and experience.

While industrial and commercial lines will undoubtedly absorb a large number of these men, the power-plant field offers opportunities which are not being overlooked by those having the work in hand; and the hearty coöperation of plant owners, managers and operatives is being sought.

A partially disabled man can be trained to render efficient service as a switchboard operator, a pump runner or attendant of other auxiliaries. In the boiler room with its stokers and modern appliances, special training and intelligence has replaced the requirements of brawn as of former days, and here is another opportunity for the partially disabled man. Also, he can be trained for work as clerk to the chief engineer in keeping records, plotting performance and figuring costs. Another occupation that is receiving special attention at the hands of the Board is that of electric welding, which is coming more and more into use in connection with power-plant work. In the engineering field in general, drafting and estimating offer attractive opportunities, and there are many other lines that could be mentioned.

In entering upon this work the Government is squarely meeting both an obligation and a social problem. It deserves not only support but active coöperation.

Why Repeal the Daylight-Saving Law?

DAYLIGHT saving proved so successful last year that it was felt in general that the practice had come to stay and that this year would see the law revised so as to make it effective throughout the year instead of from March to October. Some of the strongest opponents of the law came out openly in favor of it after one season's trial. Employers of labor everywhere were thoroughly convinced of the advantages to their employees, resulting from starting work one hour earlier in the morning and going home an hour earlier in the evening. Hundreds of thousands of people expressed themselves well pleased with the results, for not only did they have more time to get out in the open air in daylight, but their gas and electric bills were reduced. There resulted a saving of more than one and a half million tons of coal, an economy in this field far beyond expectations. The central-station interests also expressed the opinion that the law was beneficial.

In spite of all the benefit resulting from daylight saving, there has recently been such serious protests raised against the law from certain sections of the country that it has been seriously in danger of being repealed. Strange to say, these protests are coming from a class that will be least affected by the law, as they can generally adjust and arrange their working hours, irrespective of the clock, to best suit their conditions; but since they cannot see any advantage to themselves, even if they suffer no loss, they are opposed to a law that is beneficial to millions. It is gratifying to learn that Congress has let the rider, to repeal this law, attached to the agricultural bill, die, and those who fought to prevent the repeal of this law are to be congratulated on their good work for the public's interest.

If daylight saving during war time was economically correct and was beneficial to millions of people throughout the country, there is every reason for believing it is also economically correct during peace times. After a trial of a number of years several of the nations of Europe are again putting their daylight-saving laws into effect this year; in no case so far as we know are they being repealed.

During the winter seasons the central stations are all subjected to a very heavy peak load toward the end of the day, when the lighting load overlaps the industrial-power load. If the daylight-saving law is made effective the year round, the industrial load will be shifted far enough back practically to eliminate this peak, which will result not only in a saving in capacity to the central stations, but also in a saving of power to the industries. Then why not have daylight saving throughout the year? It is to be hoped that when the time comes to set the clock back next October, Congress will have made the law effective the year round.

Extending the A.S.M.E. Boiler Code to Other Pressure Vessels

THE revision of the Boiler Code of the American Society of Mechanical Engineers having been completed, it is possible that the committee may turn its attention to the formulation of codes for other pressure vessels, for which there is a demand, especially upon the part of those who are using the Code as the basis of state or municipal inspection.

To what class of pressure vessels should the attention of the committee be directed first? Service would dictate that immediate attention be paid to those classes of apparatus in the misuse of which the greatest danger lies. The wish to perfect a portion of the Code which is admittedly not up to the high standard of the remainder may lead the committee to devote its attention next to the Heating Section. A logical extension of its work upon steam boilers would be the formulation of a code for pressure heaters and economizers, in which field interesting problems await solution. And then there is the unfired-vessel field, some heated, as digesters, some the contents of which are capable of doing damage when released, as ammonia containers, gas tanks, etc. Some vessels are subjected or liable to be subjected to very high pressures, but have so little weight of contents and are capable of storing up so little energy that they offer little menace. On the other hand, systems containing large quantities of water under moderate pressure may, by a combination of conditions, accumulate a store of energy capable of disastrous effects if unintentionally released.

The committee has an interesting and useful work before it, whichever phase of the subject it turns its attention to next.

Activity and Accomplishment

TOO many men in executive positions have a distorted notion as to how time should be employed. They are of the opinion that subordinates should show continuous activity and be busy every minute of the working day. To them spare time on the part of a worker means laziness and leisure spells loss.

There are occupations in which temporary inactivity undoubtedly decreases output and so lessens profits, but they are usually positions in manufacturing establishments in which large production is maintained by specialized workers. The idea is wholly inapplicable to the power plant.

In a generating station or in a boiler room the main object is to keep the equipment operating at the required capacity. At the same time it is desirable that the plant be run with reasonable economy. To accomplish such results the working force is not obliged to be continuously on the jump, like so many waterbugs on a pond.

The best engineer is not necessarily the man who shows the greatest activity. There are occasions when the ability to move quickly and act surely and wisely are the most valuable qualifications an engineer can possess; but it is ridiculous to expect that he shall spend all the hours of his shift in sprinting around among his machines. There is such a thing as conservation of human energy.

The trouble is that a lot of folks fail to discern the vital difference between mere motion and actual accomplishment. They are pleased to see employees feverishly busy, but they never get to the point of analyzing what all that show of animation actually produces. By that very failure they miss great mental enlightenment.

If they catch the engineer enjoying a few minutes of leisure, they are apt to suspect that he is soldiering; or they may conclude that his position has so little real work connected with it that he ought to be given a few more odd jobs around the establishment. They are wholly blind to the truth that if the plant is running smoothly, leisure time is to be accounted for by the fact that every piece of apparatus is shipshape and in good repair.

If the plant employees are ceaselessly on the run, day and night, with oil can and wrench, adjusting, repairing, lubricating, fussing and perspiring in the effort to keep the wheels turning over, it is a safe bet that there is something wrong with the plant or with the attendants—and maybe with both.

The way to determine whether an engineer is an energetic whirligig or an economical worker is by the record sheet of plant performance and not by his rapidity of locomotion. A dog chasing his tail may form a veritable picture of liveliness and industry, but he produces nothing but yelps and a cloud of dust.

The review of the fuel conservation in Massachusetts by Mr. Hawley indicates that over three-fourths of the small plants in Boston were in good physical condition. If these are to be taken as fairly representative, they combat a very deep-seated conviction in certain quarters concerning the small plant. But the visits of the inspectors did show that most of these plants were sadly deficient in instruments that would enable the engineers to keep an intelligent record of the performance. This fact was confirmed by the New York Fuel Conservation, which found over sixty per cent. of the plants lacking such equipment. Yet during the war, by constant diligence the engineers were able to show remarkable savings in coal. This indicates what might be expected of many small plants where intelligent operation is combined with the proper instruments and equipment.

Newspaper Headline—NO BEER, NO WORK.

According to a news item thirty thousand members of the Essex, New Jersey, Buildings Trades Council will strike July first if war-time prohibition is placed in effect. Some people won't work without beer, and others won't work with it.

It is said that sixty days before the armistice was signed, Marshal Foch cabled to the Fuel Administration at Washington as follows: "If you don't keep up your petroleum situation, we shall lose the war." It looks as if the Fuel Administration had been on the job.

Americanization is the ingredient that will produce a strong, homogeneous alloy of the materials in our national melting pot.

Needless worry is as bad as a handful of grit in a can of lubricating oil.

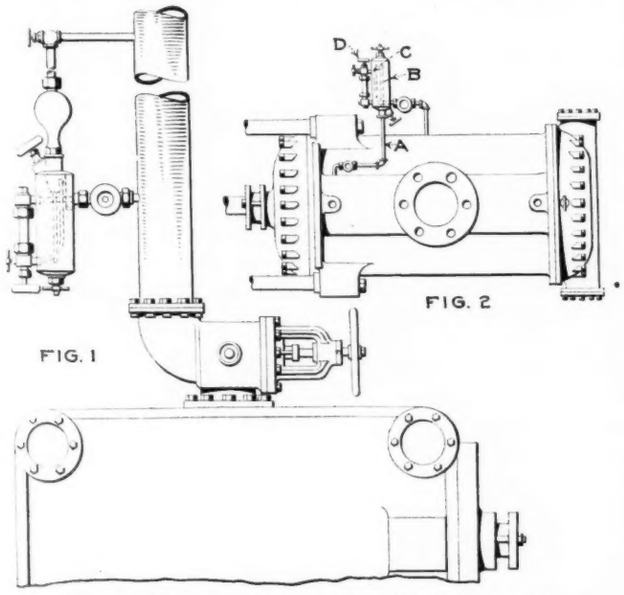
Correspondence

Lubricator on Air Compressor

In moving a large air compressor, the lubricator was accidentally broken and damaged beyond repair. When the piston was taken out, the cylinder and piston were found to be badly scored owing to lack of oil, so it was probably a good thing that the lubricator broke, as either it had not been working properly or someone had neglected to keep it filled. An old hydrostatic lubricator was found about the place, and I set about to fix it over to use on the air cylinder.

Fig. 1 shows such a lubricator as it is connected up for use with steam, and Fig. 2 shows how it was rigged on the air cylinder. The condensing chamber was taken off and the lubricator turned upside down and a connection from the discharge side of the compressor hooked in where the condensing chamber had been. The feed connection was turned down and connected into the top of the cylinder at midstroke.

The action is as follows: The air pressure enters from the discharge manifold, through the pipe *A* and tube *B* to the top (originally the bottom) of the lubricator and forces the oil out through the tube *C*, needle valve *D*, and on through the sight-feed glass and discharge tube into the compressor cylinder. The operation is positive from the fact that there is always an unbalanced pressure between the two connections because the compression pressure has only risen to about half the discharge pressure when the piston passes the discharge connection of the lubricator at midstroke, and from this point to the end of the stroke there is suction on this connection and there is always discharge pressure on the other connection.



OLD AND NEW CONNECTIONS OF LUBRICATOR

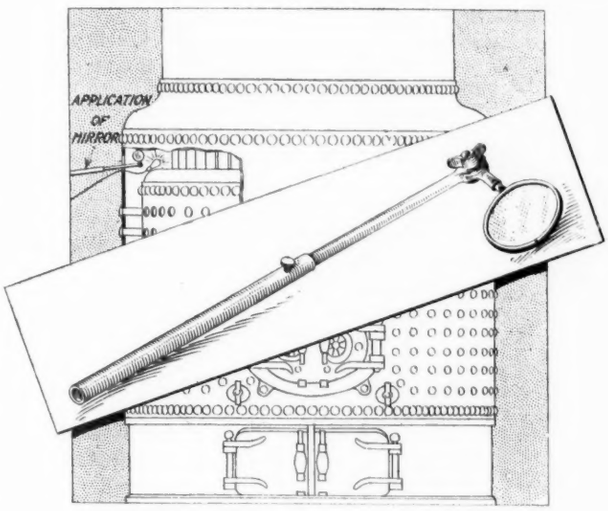
P. A. GETT.

New York City.

Plant-Inspection Mirror

Frequently, the operating engineer is called upon to inspect parts of equipment that are inaccessible because of their location or because of the interference of other objects. Therefore a reflecting instrument can be used to advantage for revealing these inaccessible views, much on the same order as the dentist's mirror.

I have made such a device, as shown by the sketch, the mirror being 6 in. in diameter, and the extension rod being of $\frac{3}{16}$- and $\frac{1}{2}$-in. brass rod. The mirror end is adjustable in any direction by means of a locknut that fastens it in its holder or by means of the swinging holder controlled by a thumb-nut. This instrument can be used in examining boilers, inaccessible pump seats, condenser shells, etc.



INSPECTION MIRROR AND ITS APPLICATION

M. A. SALLER.

Philadelphia, Penn.

Observations of a Fuel Administration Inspector

In *Power* for Jan. 21, W. F. Remliw gives his observations of the plant of which I am in charge. If he had allowed the matter to rest with his observations, they could have been passed with but slight notice. But as he chose to draw conclusions and pass judgment on the plant, particularly on the operation of the boilers, after mere casual inspection, I feel that attention should be called to the unfairness of his criticisms.

First, it should be mentioned that his inspection was made on a Sunday, when the steam demand is very light. As the firemen are required to work very hard during weekdays and must keep their fires in good condition to carry the load, I do not think it out of place to be more lenient on Sundays with a light load and when there is no urgent need for them to keep breaking up the fires continually, as they must do during the other six days

of the week. I cannot understand how anyone with fair judgment, after a casual Sunday observation with a light load, can make the statement that the plant is losing money instead of saving it, burning that fuel under those conditions. Any fair-minded engineer will feel that a statement like this, based on such superficial knowledge of conditions, is probably made with some other object in view than that of fair, impartial criticism.

For the benefit of this inspector I wish to state that the plant which he criticizes is saving money instead of losing it, and is operating on the same tonnage of mixed coal per annum that was required of the much higher-priced pea coal three years ago, before changing over to forced draft and No. 3 buckwheat.

In regard to his other criticisms—feed-pump location, open heater, and steam waste at the absorption machine—those conditions are well known to me, and application has been made to the authorities for funds to change them. In city work it has been rather difficult under war conditions to get funds for changes and repairs, as the inspector doubtless knows. When funds become available to obtain the material required for the work, no time will be lost in making these various desirable changes.

I ought to state that this inspector made his visit with a fireman unfamiliar with all the details of the plant and did not make known to me—the responsible party—the object of his visit.

M. F. MURPHY.

Brooklyn, N. Y.

Unsymmetrical Connections

In order to prevent field rheostats from becoming ground to earth, they are secured to the switchboard iron frame by means of insulated bolts and the operating end of the dial spindle is insulated from the contact

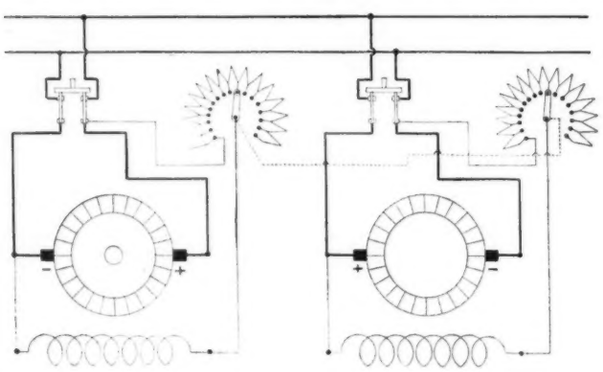


FIG. 1. CONNECTIONS WHEN TROUBLE OCCURRED

end by means of an insulating coupling. That these precautions are not always observed is indicated by the following:

An attempt to parallel two exciters resulted in the circuit-breakers opening and brushes sparking, and the automatic voltage regulator was put out of order. An inspector found the regulator to be intact excepting that the relay contacts appeared to have been handling heavy currents. Fig. 1 indicates the cause of the trouble; here the dotted line shows the two field rheostats to be connected together as a result of their windings becoming ground to their frame and of mounting the two rheostats directly on the iron framework of the switchboard. Instead of connecting the rheostats to the same busbar, as indicated in Fig. 2, they were connected to busbars of opposite polarity, as in Fig. 1, so that the closing of the main switch of the incoming machine completed a short-circuit through the two rheostats in series, further complicating the trouble.

In order to right matters, the grounds were cleared in the rheostats, their frames insulated from the switchboard frame and the connections changed to those of

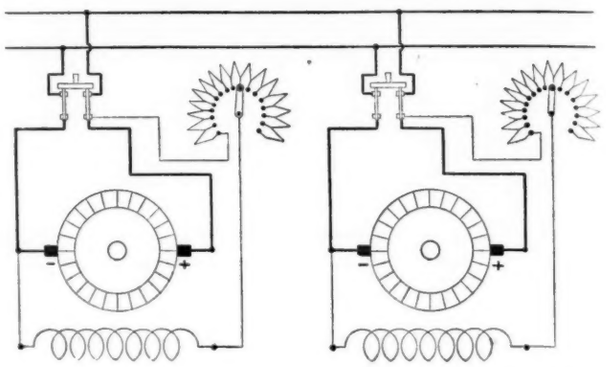


FIG. 2. CORRECT ARRANGEMENT OF CONNECTIONS

Fig. 2, in which the two machines are shown to be connected alike in all respects. This indicates that two machines should not only have the same polarity when they are paralleled but should also be connected symmetrically so as to eliminate any complications that might arise from this source in case of trouble.

Brooklyn, N. Y. E. C. PARHAM.

Tallest Chimneys in the World

I was much interested in reading a description of the 525-ft. brick chimney erected at Washoe Reduction Works, and especially in the table giving comparative data of the largest stacks in the world, on page 808, of the Dec. 3, 1918, issue. The height of the Saganoseki chimney of Japan therein quoted is sometimes misreported, and I herewith desire to correct the figures as published. The stack was constructed under my management while engaged at the Saganoseki smeltery, and consequently I am acquainted with its dimensions. It is 550 ft. high above the footing and 567 ft. above the foundation level, 570 ft., hitherto often reported, being only a rough measure including the foundation. The other data which appeared in the table about the stack are all right.

Another tall chimney, which evidently has not been mentioned in your country and which was omitted in the article "Some Tall Chimneys" in your issue of Jan. 8, 1918, on page 56, was designed by the writer and was constructed at the smelting plant of the Hitachi mine, Japan, in 1915 to minimize the smoke troubles. It is constructed on a hill and is 700 ft. high above the charging floor. It measures 511 ft. in height above the foundation, 524 ft. above the foundation level, and at the time it was built it was the highest stack in the world. The other data of the stack are as follows: Material, reinforced concrete; volume of concrete, 320 cu.yd. for foundation, 310 cu.yd. for stack; weight of steel, 174 tons for foundation, 209 tons for stack; diam-

eter of foundation, 85 ft.; inner diameter of chimney, 25 ft. 6 in. at top, 35 ft. 6 in. at bottom; thickness of wall, 8 in. at top, 24 in. at bottom; elevation of top above sea level, 1565 feet. H. MIYANAGA.

Ibaraki-Ken, Japan.

Vacuum Heating in Mild Weather

In vacuum heating systems the pressure should be decreased and the vacuum increased in mild weather and at night to "stretch out" the steam in the system, giving a lower pressure and temperature, thus radiating less heat.

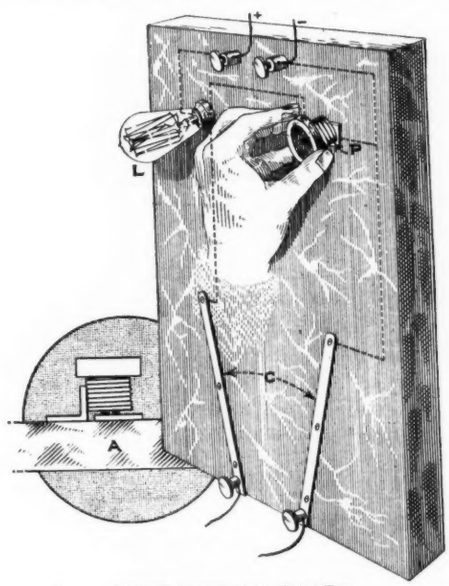
With the Paul system very good results can be obtained by shutting off the ejectors in mild weather and at night. W. T. MEINZER.

Brooklyn, N. Y.

Testing Outfit for Cartridge and Plug Fuses

I was much interested in the article, "Testing Cartridge Fuses," on page 282 of the Aug. 20, 1918, issue of *Power*.

The testing board that is shown in the figure is one that I built and used for a number of years with good results. It is made from a piece of 8 x 12-in. slate $\frac{7}{8}$ in. thick. Contact strips *C* of $\frac{1}{8}$ x $\frac{1}{2}$ x 8-in. brass are placed so that the ferrules of the smallest cartridge fuse can rest on them at the bottom ends, and far enough apart at the top to make contact with the ferrules of the largest-sized fuse. Contacts *P* for testing plug fuses are made of a small brass angle and a flat



FUSE-TESTING BOARD

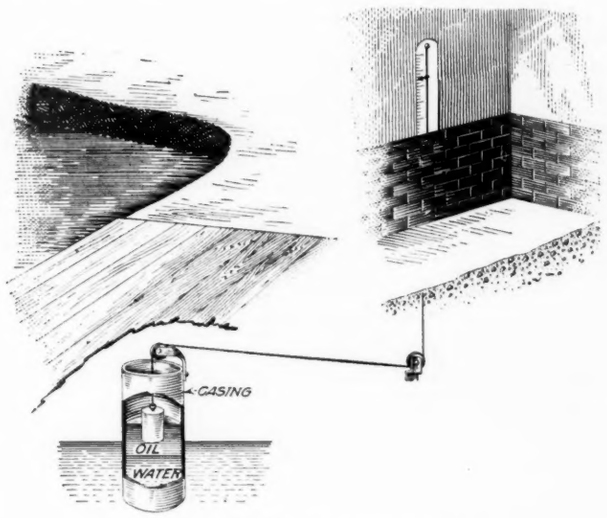
strip placed about 0.5 in. apart, as indicated at *A*. Or a lamp socket may be used after flattening out the thread in the receptacle. A lamp *L* is connected permanently in circuit.

The board may also be used for making other tests by placing a binding post at the bottom end of each of the strips *C* and test leads brought out from them, as indicated. W. F. CONDON.

Detroit, Mich.

Preventing Telltale Float from Freezing

A simple kink that I use to keep our headwater float gage from freezing and becoming inactive in a hydroelectric plant is illustrated herewith. Hourly records are kept of the height of the headwater in the flume,



NON-FREEZING TELLTALE FLOAT

and to do so a closed metal float is placed in a vertical piece of 6-in. pipe which is hung in the flume. A line from the float runs over the guide pulleys and connects to a marker that slides up and down on a graduated board attached to the side wall of the generator room, thus at all times indicating the height of the water.

To keep the float from freezing fast in the winter we put about two gallons of kerosene oil in the pipe and then recalibrate the gage, which works to perfection.

Deposit, N. Y. W. D. WAKEMAN.

Correcting An Erroneous Impression

We desire to bring to your attention an advertisement by the Baker-Dunbar-Allen Co. in the Feb. 4 issue, the text of which is highly misleading. The following matter inclosed in quotation marks are excerpts from the Baker-Dunbar-Allen Co.'s advertisement, each quotation being directly followed by our discussion:

"That was only one of the faults of the whole plant, and was one reason why the B. D. A. organization was called in to remedy this condition."

The Baker-Dunbar-Allen Co. was in no sense of the word "called in," but on the contrary requested the city for permission to bid on one of the minor contracts incident to general improvements to the Brilliant boiler plant, the plans and specifications for which work having previously been completed by the engineering force of the Bureau of Water, and at no time was the Baker-Dunbar-Allen organization called in, consulted or employed by the City of Pittsburgh in an advisory engineering capacity.

"Down in the Brilliant Pumping Station, City of Pittsburgh, they had two 500-hp. Babcock & Wilcox boilers in battery installed in such a way that the ashes had to be raked out of the ashpit by hand—obviously poor economy."

The Baker-Dunbar-Allen Co. were, being low bidders, awarded a contract by the City of Pittsburgh to move and reset on new foundations three 500-hp. Aultman-Taylor boilers. The amount of their contract was under 8 per cent. of the expenditures made to date on the general improvement scheme incident to the remodeling of a power plant in service twenty-five years and built prior to the era of modern economic power-plant apparatus.

"About the most ticklish job arising out of this problem was to move the boilers about 100 ft. horizontally and to lift them 7 ft. vertically onto a new foundation which provided ash gates of our own design under the ashpits of the boilers, permitting the direct discharge of ashes."

The boilers were actually moved 50 ft. horizontally and 3 ft. vertically.

The claim of having designed and installed special ash gates under these boilers is without the slightest foundation in fact, no such equipment ever having been considered or installed.

We feel that you will appreciate an opportunity to correct the erroneous impression conveyed to your readers by the advertisement mentioned, and to this end respectfully request publication of this letter in your columns.

F. W. LYON,
Division Superintendent,
Bureau of Water.

Pittsburgh, Penn.

Use of Turbine Blowers

The article on "Fans and Blowers in the Power Plant," by Rufus T. Strohm, in the issue of Feb. 4, contains no reference to the undergrate turbine blower that is so extensively used today for forced draft. There is a brief reference to a propeller-type fan, but it is stated that its use is similar to that of the disk fan, and Mr. Strohm makes absolutely no reference to the use of the propeller fan for delivering air against moderately high pressures, particularly for forced-draft work.

The publication of such an article creates certain impressions in the minds of readers, and the impression which many of them may be inclined to get is that the turbine-driven blower for undergrate draft is a rarely used machine, whereas it is quite the contrary; so much so that I believe there are far more small and moderate-sized isolated power plants today using these blowers than are using blowers of any other type.

V. H. CARPLES.

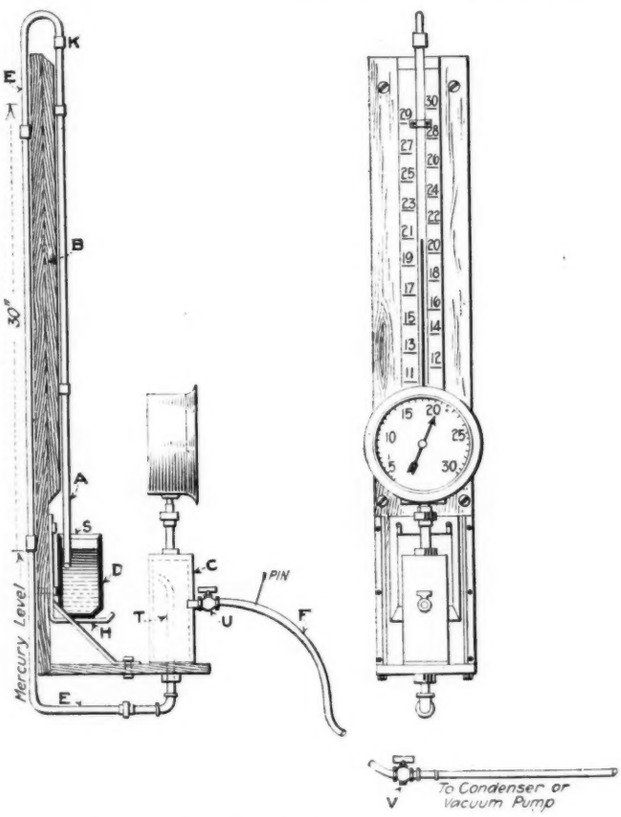
New York City.

Vacuum-Gage Test Column

The illustration shows a vacuum gage test board, an instrument seldom found in a power plant. This device can be made from material found about the plant. A description of the test board follows.

A mercury-column glass tube *A*, $\frac{5}{16}$ in. outside diameter, having a $\frac{1}{16}$-in. hole, and 34 in. long, is secured to the board *B*, as shown. To the shelf of the board is attached a short piece of 2-in. pipe *C*, plugged at both ends, the top end being tapped for a $\frac{3}{8}$-in. pipe and the bottom end for a $\frac{1}{4}$-in. pipe. In this piece of pipe is a bent tube *T*. It is bent for two reasons—to prevent anything from dropping into the pipe and so that in case of accident if mercury is drawn over from the mercury gage, it will collect in the reservoir.

Attached to the gage board is a bracket *H*, having oblong bolt holes so that it can be adjusted up or down to get the mercury level, the mercury being contained in a common drinking glass *D* covered with a cork or wooden covers. A pipe or rubber hose *E* is connected to the top of the mercury column and to the bottom of the cylinder *C*. If a pipe is used, it is connected to the glass tube by a rubber nipple *K*. Of course there



APPARATUS FOR TESTING VACUUM GAGE

must be a vacuum pump or condenser in the plant; if not, a vacuum gage is not needed. A test pump is eliminated, and so there is nothing to get out of order.

To operate, attach the vacuum gage to be tested as shown and open the cock *V*. Then very slowly open the cock *U* just enough to start the mercury up into column *A*. When the mercury is at its height limit, shut the cock *V*, and if everything is tight the mercury will be at a standstill. Then connect the gage with the mercury column. For testing at various points, lower the mercury to any graduation and make a pinhole in the connecting hose near the cock *U*, and when the mercury drops to the point desired put a finger over the pinhole. In this way one can test a gage with a mercury column all the way down from zero to the limit of the gage. If there is a slight leak in the connection and the mercury will not stay up with the cock shut, open it just enough to balance the mercury.

LOUIS G. O'DONNELL.

Cos Cob, Conn.

Because of the nature and extent of the equipment needed, the successful exploitation of oil-shale deposits involves large capital and technical chemical ability.

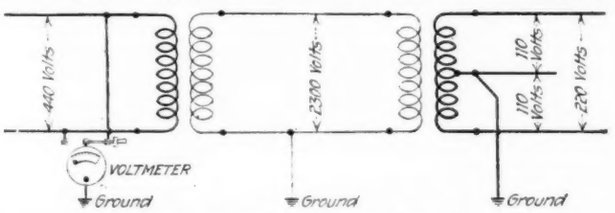
Inquiries of General Interest

States and Cities That Have Adopted the A. S. M. E. Boiler Code—What states and cities of the United States have adopted the A. S. M. E. Boiler Code? D. M. B.

The A. S. M. E. Boiler Code has been adopted by the States of California, Michigan, Minnesota, New Jersey, New York, Ohio and Pennsylvania, and is enforced independently of state laws by local boiler regulations of Allegheny County, Erie and Philadelphia, Penn.; Kansas City, St. Joseph and St. Louis, Mo.; and Detroit, Mich. In the City of Chicago, Ill., and in the States of Indiana and Wisconsin, boilers constructed in conformity with the A. S. M. E. Boiler Code are acceptable in lieu of the requirements of local laws and ordinances.

Ground Detector Voltmeter—We have a lighting system stepping up from 440 volts through a transformer to 2300 volts for transmission and then stepping down to 110-220 volts for lighting service. If a ground occurs on either the 2300- or the 110-volt line, will it indicate on the ground-detecting voltmeter on the 440 supply? E. K.

It is evident from the figure that a ground on either the 2300-volt or the 110-volt system will not be indicated on the ground-detecting voltmeter on the 440-volt supply,



since each system is insulated from the other. However, the 2300-volt system should be kept insulated from ground, since a ground on the high voltage subjects the insulation between the primary and secondary windings to the full voltage of the transformer.

Testing Feed Water for Oil Received in Open Heater—How can a test be made to determine the amount of oil added to the feed water by an open exhaust-steam feed-water heater? F. P. H.

Make up about one pint of a concentrated solution of caustic soda and dilute with an equal quantity of water, using melted snow or ice water or the purest water conveniently obtainable. Provide two clean glass beakers and fill one about half full with a sample of the water received by the heater; mark the height on the side of the beaker and turn the water over into the other beaker. Refill the first beaker to the same point with a sample of the water discharged from the heater, and beginning with about 4 oz. of the caustic soda solution in a measuring beaker such as used by chemists and photographers, add sufficient of the soda solution to the sample of discharge water to cause it to become decidedly turbid, then add precisely the same amount of the soda solution to the sample of the water received by the heater. If the latter becomes turbid, repeat the experiment with perfectly clean beakers, each time using smaller equal quantities of the soda solution. This done, each beaker will contain the same quantity of soda solution and of the respective samples of water, and it may be noted how much engine-cylinder oil needs to be added to the beaker containing the sample of water received by the heater to bring it to the same appearance of turbidity as the contents of the beaker containing the same amount of water discharged by the heater and the same dose of soda water. This will not only indicate the presence of oil but, by repeating the experiment on a large enough scale, will demonstrate the ratio of the quantity of oil to quantity of sample water tested.

Repairs to Leaky Piston Valves—How can leaky piston valves be made tight? R. D.

If leakage is from wear or cutting of the valve seats they will need reboring and in nearly every case the packing rings will need to be replaced, for although the old rings may show no signs of cutting, they will be worn to shapes that will not conform to the rebored seats.

Tangye-Frame and Girder-Frame Engines—What is the meaning of "Tangye-frame" and of "girder-frame" engine? P. E. R.

The designation "Tangye" bed, or frame, is employed in American engine practice with reference to an engine frame such as illustrated by Fig. 1, consisting of a single

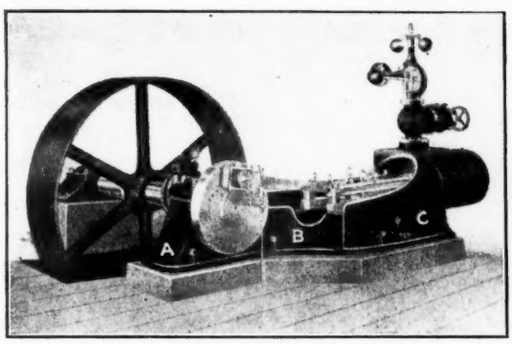


FIG. 1. TANGYE-FRAME ENGINE

casting *A B C* of ogee form for an overhung crank and resting full length on the foundation, with the main bearing at one end of the frame and the cylinder usually overhung and stud-bolted to the other end of the frame.

The girder frame takes its name from the fact that the part of the engine frame *A B*, Fig. 2, between the main bearing and the cylinder, does not rest directly on the foundation, but acts as a girder, which usually is supported by

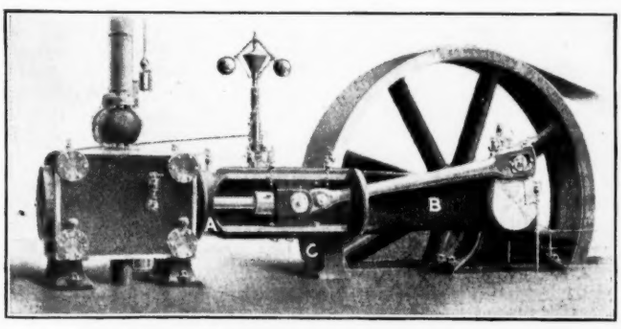


FIG. 2. GIRDER-FRAME ENGINE

a stand *C*, or legs, placed about the middle of its length. The cross-section of the girder frame between the guides and the main bearing generally is made in the shape of a letter T or channel beam to impart greater stiffness for the weight of metal used. The guides are most commonly part of the frame itself, either bored to a circular shape or planed V-shape.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for inquiries to receive attention.—EDITOR.]

Lubrication of Air Compressors*

By H. V. CONRAD

SATISFACTORY lubrication of air-compressor cylinders is attained by securing the reduction of friction to a minimum and the elimination of carbonization of the oil as far as possible. For the proper reduction of friction the oil chosen should have sufficient body to sustain the weight of the moving parts and to form a seal between the piston rings and the cylinder walls, and still not absorb excessive power in the overcoming of the viscosity of the oil itself.

Carbonization of the oil allows the accumulation of deposits of carbon which are sticky in the early stages of their formation, but hard and flinty later. Such deposits accumulate on the cylinder valves, in the cylinder passages, in the pipes and eventually in the air receiver. Sticking or partial closing of the valves and their consequent failure to act properly is probably the chief objection to this action from the standpoint of the efficient operation of the compressor. The formation of excessive carbon deposits is apt to be due to one or more of the following causes: (1) The ill-advised use of some oil, such as a steam cylinder oil, which easily decomposes in the heat of the air cylinder; (2) the use of oils of too great a viscosity; (3) the use of too great quantities of oil; (4) the failure to provide a proper screen over the air intake of the compressor, thus allowing free entrance of dangerous dust (especially coal dust).

The objections to this carbonization aside from the sticking of air valves and choking of the air passages is the menace of fire. Particles torn loose from carbon deposits may become incandescent from causes which could not be anticipated by the compressor manufacturer. If such incandescent carbon particles should happen to come in contact with oil vapor given off by the lubricating oil, a fire might possibly be started whose menace would be small or large depending upon how much carbon had been allowed to accumulate in the compressor and piping to the receiver.

TABLE I. CYLINDER TEMPERATURES AT END OF PISTON STROKE

Final Pressure of Air, Lb. Gage	Final Temperature, Deg. F. Single-Stage	Two-Stage	Final Pressure of Air, Lb. Gage	Final Temperature, Deg. F. Single-Stage	Two-Stage
10	145	...	100	485	243
20	207	...	110	507	250
30	255	...	120	529	257
40	302	...	130	550	265
50	339	188	140	570	272
60	375	203	150	589	279
70	405	214	200	672	309
80	432	224	250	749	331
90	459	234	...	...	...

The selection of an air-cylinder lubricant is, of course, governed to a considerable extent by a knowledge of cylinder temperature it must withstand. Knowing the air pressures, the corresponding temperatures are ascertained fairly accurately, as shown in Table I. This table gives the final temperature in the cylinder at the end of the compression stroke, for single-stage, also for two-stage (or compound) compression, when the free air entering the cylinder is at 60 deg. F. Variations from these temperatures will occur in actual practice owing to water-jacketed air cylinders and radiation, tending to lower the temperature at the higher pressures. But at, say, 50 lb. pressure and lower, the heat is likely to be somewhat greater than given by the table, particularly if the compressor is run at high speed and also if it is not water-jacketed.

The natural inference of the reader after noting the temperatures in Table I is that he must select an air-cylinder oil whose flash point is higher than the maximum temperature likely to be encountered within the air cylinder. As a matter of fact, this is not the case and it need only be carefully noted that the study of the air-cylinder temperatures is useful mainly in testing lubricating oils to determine their resistance against breaking down into carbon, etc. But such temperatures cannot be taken as limits establishing the highest allowable flash point for a lubricant safe to use in the air cylinders.

For average normal conditions the oil should be a medium-bodied pure mineral oil of the highest quality, not compounded with fixed oils such as animal or vegetable, and should be carefully filtered in the final process of manufacture. Quite a range of oil composition is permissible for lubricants approved for this work, which are manufactured under the foregoing conditions. Primarily, a distinction must be made between those oils having a paraffin base as distinguished from those having an asphaltic base.

From a strictly operating standpoint—so it is claimed by some lubricant manufacturers—there is no distinction between these two classes of lubricants as to their desirability as compressor-cylinder oils, provided both have been properly filtered in the process of manufacture to remove the carbon-forming elements. If any carbon should be formed, however, such carbon deposited by the asphaltic-base oils is of a light fluffy nature and easily cleaned out, whereas that deposited by the paraffin-base oil is very adhesive and is characterized by a hard, flinty nature.

Merely as a guide to aid the operator in specifying the qualities to be possessed by an air-cylinder lubricant recommended for average duty, Table II is presented. It is

TABLE II. PHYSICAL TESTS OF PARAFFIN-BASE OILS

	Minimum	Average	Maximum
Gravity, Baumé	28 to 32 deg.	25 to 30 deg.	25 to 27 deg.
Flash point, open cup	375 to 400 deg. F.	400 to 425 deg. F.	425 to 500 deg. F
Fire point	425 to 450 deg. F.	450 to 475 deg. F.	475 to 575 deg. F
Viscosity (Saybolt) at 100 deg. F	120 to 180 sec.	230 to 315 sec.	to 1500 sec.
Color	Yellowish	Reddish	Dark red to green
Congealing point (pour test)	20 to 25 deg. F.	30 deg. F.	30 to 45 deg. F

suggested that those oils within the range expressed by the minimum figures be used for low-pressures and temperatures, while those expressed by maximum figures should be used for high pressures and temperatures.

It is recommended that any paraffin-base lubricant intended for use in all standard air compressors should meet the physical tests imposed by the average range of figures given in the middle column of Table II. The wording "standard air compressors" is to be interpreted as including the following types of machines: (a) Low-pressure up to 100 lb. compressors, which may be either small-sized single-stage units, or larger-sized compound machines; (b) high-pressure compressors which are constructed with the proper number of stages so that no excessive temperatures are ever reached.

The asphaltic-base group of oils is considered separately for the reason that the lower limit of gravity stated in Table II, namely, 25 deg. Baumé, eliminates this entire group from consideration—which is not the intention of this article. As a guide for the selection of suitable oil, Table III is given. For general all-around use, it is conceded that the recommendations given in Tables II and III cover the situation as well as possible, special cases, of course, requiring investigation and special consideration before making recommendations.

TABLE III. PHYSICAL TESTS OF ASPHALTIC-BASE OILS

	Minimum	Average	Maximum
Gravity, Baumé	20 to 22 deg. F.	19.8 to 21 deg. F.	19.5 to 20.5 deg. F
Flash point, open cup	305 to 325 deg. F.	315 to 335 deg. F.	330 to 375 deg. F
Fire point	360 to 380 deg. F.	370 to 400 deg. F.	385 to 440 deg. F.
Viscosity (Saybolt) at 100 deg. F	175 to 225 sec.	275 to 325 sec.	475 to 750 sec.
Color	Pale yellow	Pale yellow	Pale yellow
Congealing point (pour test)	0 deg. F.	0 deg. F.	0 deg. F.

The quantity of lubricating oil to feed to the air cylinders of compressors cannot be stated in exact terms due to the varying viscosity of different oils, the heat of compression and the size of cylinder. It may be stated in general, however, that after the cylinders have acquired smooth and polished surfaces, the quantity should be reduced to the lowest limit to avoid the possibility of the accumulation of carbon and sooty deposits within the system. The basis of quantity given in Table IV is recommended, sub-

*Abstract of a paper prepared by the Compressed Air Society.

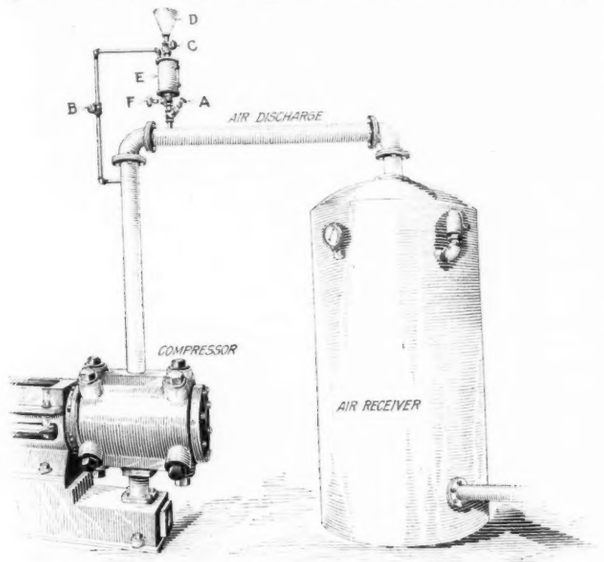
ject to modifications already mentioned, for these cylinders or equivalent sizes operating under normal conditions.

The results in the last column of Table IV are based on the assumption that under average conditions of temperature and usual range of oil viscosities, a pint of oil will contain an average of about 16,000 drops. These figures are offered merely as an approximate guide.

TABLE IV. QUANTITY OF AIR-CYLINDER LUBRICANT REQUIRED PER 10-HOUR DAY

Size of Cylinder, In.	Displacement per Minute Cu.Ft	Piston Speed, Ft. per Min	Sq.Ft. of Cylinder Wall Swept by Piston	Drops of Oil per Min.	Drops of Oil per 10 Hr.	Sq.Ft. Oiled per Drop	Pints of Oil per 10 Hr.
8x 8	120	344	718	1	600	718	0.0375
12x12	320	408	1230	2	1200	613	0.0750
18x18	880	496	2340	4	2400	585	0.1500
24x24	1730	550	3450	6	3600	575	0.2250
30x30	2940	600	4700	8	4800	590	0.3000
36x36	4550	644	6070	10	6000	607	0.3750
42x42	6700	696	7600	12	7200	633	0.4500

A leading authority on compressor engineering contributes the following: "The best way to determine the proper amount of lubrication is to take out the valves



DEVICE FOR CLEANING CARBON FROM DISCHARGE LINE AND RECEIVER

from time to time and examine the cylinder. All parts should feel that there is oil thereon. If they feel dry, the lubricators should be adjusted to feed a little more oil, whereas if oil lies in the cylinder and its parts show excessive oil thereon, the quantity fed by the lubricators should be reduced. By thus examining the machine a few times, the proper amount of oil can be determined to suit the characteristics of the particular lubricant used and the conditions under which the machine operates."

The best of lubricating oils will deposit enough carbon in the compressor system to necessitate periodical cleansing. For the removal of carbon, the machine operator should confine his efforts to the use of soapsuds. A good cleansing solution is made of one part of soft soap to fifteen parts of water. The suds should take the place of oil for a few hours, and be fed into the air cylinders about once a week, either by means of a hand pump or through the regular lubricator about ten times as rapidly as oil. The cleanliness of the air valves when inspected, as they should be periodically, will indicate whether greater or lesser applications of the soapsuds should be made. After using soapsuds, open the drain cock of the air receiver, and of the intercooler in the case of compound machines, to draw off any accumulated liquid. Oil should be used again for a half-hour before shutting down the machine in order to prevent rusting the cylinder and its fittings. Never use kerosene, gasoline or lighter oils in an air cylinder for any purpose, because of their volatile nature.

It often happens that oil, carbon and other foreign matter are deposited in the air-discharge lines and air receiver. A practical method of cleaning these is shown in the illustration, where a compound chamber made of 6-in. pipe is shown set on top of the discharge pipe. If a mixture of 1 lb. of Red Seal lye and 18 lb. of water is passed into the discharge line at the rate of 60 or 70 drops per minute while the compressor is running, it will eat out the accumulation on the surface of the pipe and in the receiver, and if the blowoff valve on the receiver is open, all this foreign matter will be discharged therefrom. To use the compound, close the cocks *A* and *B*, open the valve *C*, and pour the lye mixture into the funnel *D*. When the chamber *E* is filled, close the valve *C*, open the cocks *B* and *A*, and regulate the feed by the valve *F*. The cleaning solution can be used every month or two or, depending on how much accumulation there may be in the receiver.

Approximately four times as much oil will be needed in the steam cylinders as in those for air, subject, of course, to variable local conditions. Depending on its viscosity, a pint of steam-cylinder oil will furnish from 5000 to 8000 drops. Taking an average of about 6500 drops, and four times as much oil as air cylinders of same size, and working at same piston speeds, as given in Table III, the recommended amounts to feed the steam cylinders or their equivalents are given in Table V. These figures are approximate

TABLE V. OIL REQUIRED FOR STEAM-CYLINDER LUBRICATION

Size of Cylinder, In.	Drops of Oil per Min.	Pints of Oil per 10 Hr.
8x 8	4	0 4
12x12	8	0 75
18x18	16	1 5
24x24	24	2. 25
30x30	32	3 0
36x36	40	3 75
42x42	48	4 5

only, and will vary with the steam conditions, the kind of oil used and its method of introduction into the steam, also with boiler compound carried by the steam into cylinder.

Detroit Engineers Approve Proposed Registration Bill

The subject of the registration of engineers has been under consideration by the Michigan Engineering Society for several years, and a bill designed to accomplish that end was presented at its last annual convention and was afterward submitted to an informal conference attended by about twenty-five representatives of the various architectural and engineering societies of the state, and after extended deliberation and discussion was redrawn and approved. The bill has been introduced in the state legislature, and probably final action will be taken soon. At its meeting on Feb. 21, the Detroit Engineering Society indorsed the revised draft of the bill. The proposed act:

1. Provides for the voluntary registration of any engineer now engaged in the practice of the profession, in whatever branches thereof he may prove himself qualified.

2. Provides for the compulsory examination, classification and registration of all persons hereafter desiring to begin practicing as architects or engineers, and establishes a minimum standard of qualifications for such persons.

3. Supersedes the existing architects' registration law and subjects the architectural and engineering professions to the same general regulations, with appropriate tests for each.

4. Provides a board of registered architects and engineers for the administration of the law.

5. Does not restrict any person now engaged in practice as an architect or engineer from continuing so to practice, except in public work.

6. Does not require any such person to be examined or registered unless he uses the title registered architect or registered engineer.

7. Does not require registered architects to register until 1921.

8. Does not prohibit the performance of architectural or engineering work by anyone not calling himself architect or engineer.

When Coal Oil Johnny Goes to Sea*

THE fast clipper ship was built of wood and propelled by sails. We had the timber to build that type of ship and the ingenuity to apply wind power and beat the world in speed. Those were the days of the Yankee clipper ships, and from Revolutionary times until 1861 we carried from 60 to 90 per cent. of our own world trade. John Bull took first place in the new kind of shipping. The proportion of American trade carried in American ships steadily ran down to less than 10 per cent. at the outbreak of the world war. Today we are about to see another revolutionary advance in merchant ships, and the United States will again have some advantage—if we back natural resources with national ingenuity.

Petroleum is the coming factor in shipping. It will be used under boilers to raise steam. Better yet, it will propel internal-combustion engines of the Diesel type—the motor ship. We have an advantage in our large output of petroleum—65 per cent. of the world's output. And we are handiest to Mexico's supplies, now nearly 8 per cent. of the world production, with remarkable possibilities for increase and two types of crude oil that are peculiarly suited to marine use.

Petroleum is about to effect a transformation in world shipping much more remarkable than that which was wrought by steam. The possibilities are fascinating. Both the oil-burning and the motor ship remove handicaps under which the merchant navies of the world have been steadily degenerating. They reduce operating costs, increase range and flexibility, overcome certain international political handicaps in shipping, and improve the living standards and morale of those who go down to the sea in ships.

When Coal Oil Johnny steps aboard a merchant ship and takes charge of the engine room the transformation is great. The comparatively few shipping managers who have operated with petroleum will tell you that it is like switching from the one-hoss shay to a high-powered racing car.

Take the advantages found in the oil-burning ship with steam engines over the coal burner. There is a reduction in the number of men needed in the boiler room, first of all. Next comes reduction in bunker space, with an increase in cargo space. A ton of oil takes 5 cu.ft. less space than a ton of coal and gives 80 per cent. steaming efficiency against 65 per cent. for coal. This works out to about 40 per cent. saving in bunker space, which is made available for cargo in a freighter. Moreover, there is a saving in quarters for the crew, because an oil-burning ship carries fewer men.

Oil-burning vessels will make from 10 to 20 per cent. more mileage than coal burners. There is better control of steaming, because fires can be started and stopped instantly, steam raised quickly and time in port saved through the greater ease of taking on oil as contrasted with coal. There are other advantages: Oil is often cheaper than coal in actual dollars—prices vary widely, of course. Oil does not deteriorate in storage like coal. Oil eliminates the fire risk from spontaneous combustion in coal, and is not subject to the danger of shifting in rough weather at sea. Oil eliminates ashes and ash conveyors, smoke and soot and the necessity for frequently painting a ship. Oil reduces the expense of grate repairs, corrosion of boiler plates, fuel-handling devices afloat and ashore.

The oil burner has a radius of from two to three times that of the coal burner. Fast passenger liners burning oil for steam could almost make the round trip from New York to Europe and back, taking most of their oil on this side; and with freight steamers running at slower speeds and burning less oil to the mile, it would be possible for them to go half round the world.

Coal Oil Johnny can give almost any coal-burning steamer seven-league sea boots by a few simple changes in equipment—the installation of oil burners under the boilers and the conversion of coal bunkers or double bottoms into oil tanks. But even that is only half his potential efficiency. Look a little farther ahead and design your ship to run with internal-combustion engines of the Diesel type, and he can double the efficiency.

The motor ship will operate on about half as much oil as the oil-burning steamer. Its engine-room force is reduced still more—from one to three men are sufficient; and there are no stokers, for the motor ship's mechanical staff is made up of skilled men. With the world's merchant fleets equipped entirely as motor ships, from 80 to 90 per cent. of the bunkering stations around the globe could be abolished; ships would require fuel only about twice in going around the world—or at an average of every six weeks. There need be no isolated fuel stations; oil would be taken on only where ships called for cargo or passengers.

Anyone who has made a voyage through the Tropics will find it interesting to contrast this sort of ship with his recollections of coaling incidents. If his voyage was through the Suez Canal to Australia or India, for instance, he remembers the terrific heat and how only Chinese coolies can stand the temperature of the fire hold; and how the ship was coaled at Port Said by hundreds of women carrying baskets of fuel. Neither the motor ship nor the oil-burning steamer requires coaling. The engine room of a motor ship need be little warmer than the deck in the Tropics; and, besides, there is probably only one man attending the engines, and he is not performing hard manual labor nor is he in dirty surroundings.

The boiler room of an oil-burning steamer can be 25 deg. cooler than if coal were burned under the same boilers. For most of the heat in a fire hold comes from opening the furnace doors to throw in coal. There are no furnace doors when oil is burned. With coal, heat escapes every time the furnace door is opened and is lost for steam-making purposes. With oil, there is no furnace door to open and more of the heat is used for steam making.

With the motor ship we can have an entirely new era in ocean transportation. It calls for skill and effects economies that will yield good wages; and its flexibility and speed should facilitate rearrangement of the world's shipping routes, so the seaman may get home more frequently and have a home worth getting to. The motor ship is here. But it still needs development and application. Thus far it has been built chiefly in small-tonnage freighters running at moderate speed. These have been highly successful economically; but there are still certain shortcomings in machinery and organization to be dealt with.

The Diesel engine must be freed of some defects that have appeared under the stress of ocean voyages, and must also be built in larger units to furnish greater horsepower for bigger ships running at higher speed. The problems are now entirely questions of engineering, and American ingenuity should prove adequate to develop the fast motor liner for passenger traffic.

If the world should turn during the next 10 years from coal to fuel oil, and from steam to the motor ship, the question of petroleum supplies will become important. At present the largest marine consumption of petroleum in the world is probably that of the United States Navy, estimated at 5,000,000 bbl. yearly under war conditions. This quantity would not go far in operating an American merchant marine of 25,000,000 tons. Data upon which to figure consumption for such a fleet, with types of passenger and cargo ships running at various speeds and in various classes of service, are not yet very ample. But engineers have adopted a rough-and-ready ratio, estimating 1 ton of oil yearly to a ton of dead-weight shipping, where the fuel is burned for steam, and half a ton yearly for motor ships.

On this basis the American merchant marine alone would require 150,000,000 bbl. yearly for steam, or 75,000,000 bbl. for motor ships. The world's ocean tonnage was 50,000,000 tons before the war, and under the improvement and cheapening in transportation, made possible through petroleum, might increase to 75,000,000 tons within the next five or

*Abstract of a bulletin by Edward N. Hurley, Chairman United States Shipping Board.

ten years, this estimate including our own merchant marine. Thus, for 75,000,000 tons of motor ships there would be required yearly somewhere between 200,000,000 and 250,000,000 bbl. of crude oil. This is approximately half of the world's total present production, and more than 80 per cent. of our own production.

Where is the oil to come from?

Fortunately, nature has stored supplies in the earth for precisely this situation. Mexican petroleum is peculiarly suited for marine use. In the district round Tampico, which has been the scene of petroleum development for the past 18 years, there are two types of crude oil taken from opposite side of the Panuco River, which runs through Tampico and divides the district. The northern type of oil is a heavy crude oil that cannot be refined, but is suitable for burning to make steam. The southern type of oil is lighter. When refined this yields about 12 per cent. of crude gasoline and is suited for Diesel engines. No such oil field has yet been located in any other part of the world. The Tampico district now has about fifty wells in production with an estimated capacity of 1,500,000 bbl. daily—more than twice as much oil as would be needed to operate the world's merchant fleets and navies.

It is true that Mexico at present produces only from 50,000,000 to 60,000,000 bbl. yearly; but this represents simply the quantity that can be handled in available pipe lines and tank steamers. The Tampico district is less than 150 miles long and 50 miles wide; but it lies over enormous reservoirs of oil and is considered but part of a general oil region 1600 miles long and from 75 to 100 miles wide. Prospectors have also found promising oil indications in Guatemala, Venezuela, Colombia, Ecuador and other parts of Latin America.

Political unrest in Mexico is still a serious handicap to oil production, the construction of new pipe lines and port facilities, and the investment of additional capital by outside operating companies. But by the time the world's improved merchant fleets are ready for the transformation of petroleum, it is to be hoped that Mexico will have worked out political stability. The petroleum lies beneath her soil. Its efficient use means not only wealth to her but benefit to all nations.

Again Water-Power Legislation Fails

The proposed water-power legislation which has been before Congress for the seven years of the present Administration failed of passage when Congress expired sine die Mar. 4. After lengthy debate in committee and on the floor of both houses, conferees on the part of the House and the Senate agreed to favorably report the bill, which would undoubtedly have passed both houses if it could have been reached on the calendar before the expiration of the Congress. The proposed legislation did pass the House of Representatives a few days before the end of Congress by vote of 264 to 65.

The proposed legislation failed to pass in the Senate, however, because it became entangled in the meshes of the filibuster which was conducted by Senators who are opposed to the President's policy as to foreign affairs. Although there were informal assurances to Senators who had charge of the proposed legislation that there were at least 80 votes in favor of the measure in case it could be brought before the Senate, the bill did not obtain a hearing because of the filibuster, which prevented this and many other important proposed laws of vital consequence to the development of industrial America.

It will now be necessary for the advocates of water-power legislation to begin to open a campaign of education for the benefit of the new members of the House of Representatives and Senate.

Obituary

Malcolm Gifford, president of the Gifford-Wood Co., of Hudson, N. Y., died on Mar. 5 after an operation at a sanitarium in West 61st St., New York City. He is survived by his widow and two children.

Personals

T. E. Butterfield, Associate Professor of mechanical engineering at Lehigh University, is back after service on the teaching staff of the Post Artillery School at Fort Monroe, Va., where he held the rank of major.

Martin T. Hooper, formerly supervising mechanical engineer to the officer in charge of construction, Langley Field, Hampton, Va., has resigned to become assistant to the superintendent of machinery of the Virginia Shipbuilding Corp., Alexandria, Va.

Engineering Affairs

The American Electro-Chemical Society, Pittsburgh section, will hold a meeting on Mar. 14, at which many important papers will be discussed.

The New England Waterworks' Association will hold a meeting on Mar. 12 at the Hotel Brunswick, Copley Square, Boston, Mass.

Bridgeport Association No. 4, of Connecticut, held its annual banquet at the Stratfield Hotel, Thursday, Feb. 27. The attendance included the ladies. There was an entertainment, and dancing concluded the festivities.

Business Items

Schaeffer and Budenberg have opened an office at Tulsa, Okla., with T. C. Eales in charge as local manager.

John G. Robel, Inc., has moved its offices from 608 So. Dearborn St. to the Garland Building, 58 E. Washington St., Chicago.

The Dearborn Chemical Co. has opened an office at 206 Commerce Trust Building, Kansas City, Mo., with G. M. Massen and W. H. Fairlamb, who are the company's representatives in that territory, in charge.

The Morse Chain Co. announces the removal of its Kansas City offices from the R. A. Long Building to more commodious quarters at 211-212 Finance Building, with W. V. Warner as district manager in charge.

The Chicago Pneumatic Tool Co. announces the removal of its Cleveland district office from Room 813 to Rooms 406-408 Engineers' Building. Ross Watson, district manager, will gladly welcome visitors to the new offices.

The Standard Oil Co. at its Whiting refinery will equip its 21,000-hp. boiler with a full-load capacity of 40,000-hp. The company is also installing a new refrigerating plant with a daily capacity of 400 tons. Other improvements include a new coal bunker 200 ft. wide, 1000 ft. long and 25 ft. deep, with a capacity of more than 125,000 tons.

The Factory Products Corp., New York City, has become associated with the Engineers' Corp., a subsidiary of the J. G. White Engineering Corp., for the special purpose of exporting American machinery and building products. The trade connections of the consolidated corporation are extensive, and its policy is to infiltrate existing markets thoroughly with American goods before expanding to new quarters of the world.

Trade Catalogs

The Baker-Dunbar-Allen Co. of Pittsburgh, Penn., has issued Bulletin A descriptive of its ash gate for underfeed-stoker practice. Copy may be had from the company free upon request.

Foster Waste Heat Type Marine Superheaters—Power Specialty Co., New York City. Bulletin M-2, Pages 32, 6 x 9 in. A booklet of general instructions containing useful information on this type of superheater.

"A Chain of Evidence" is the title of Bulletin No. 16, which is the fourth of a series issued by the Morse Chain Co. of Ithaca, N. Y. This is subtitled "Small Power Drives," but embraces medium power drives between 5-hp. and 200-hp.

The Combustion Engineering Corp., New York City, has just issued its Type "H" Stoker Bulletin H-1. It covers automatic stokers for all kinds of industrial and heat-treatment furnaces. A copy of this bulletin may be had free upon request.

Coppus Centrifugal Turbo Boiler Feed Pump. Coppus Engineering and Equipment Co., Worcester, Mass. This catalog contains useful information under the subtitle, "A New Development in Boiler Feed Pumps," and may be obtained from the company free upon request.

"Dixon's Graphite Products" is the title of a new pocket catalog issued by the Joseph Dixon Crucible Co. of Jersey City. While not so complete as the large general catalog, it furnishes a good idea of the variety of products made by this old concern. Pages have been devoted to lists of articles especially for mills, railroads, automobiles, etc. The descriptions are brief, but the company will gladly send pamphlets dealing in detail with any of the individual members of the line. This new catalog should be in the file of everyone who has occasion to use lubricants. Ask for Booklet No. 94-KP.

The Ingersoll-Rand Co., Easton, Penn., has issued the following: Form 9120, 4 pages, 6 x 9 in.; catalog on Leyner Oil Furnace No. 3. Form 9010, 4 pages, 6 x 9 in.; catalog on the "Sergeant" ticket-cancelling box. This ticket box is being used successfully in all places where great quantities of tickets must be disposed of without possibility of their ever being placed in circulation again. Form 9123, 24 pages, 6 x 9 in.; catalog on "Imperial" Tie Tamping Outfits. Profusely illustrated, showing application of the tie tamping outfit on many of the important railroads in the United States. Form 9026, 12 pages; catalog on Ingersoll-Rand High-Speed Piston Valve Steam Engine, Class "F." This engine is of the horizontal center-crank type, and the steam valve is of the most approved design, permitting the use of the highest steam pressures and superheated steam. Catalog contains cross-sectional illustrations showing the machine in detail. Form 9028; 18-page catalog on Ingersoll-Rand Equipment for Sugar Factory and Refinery Service. This catalog is offered in both English and Spanish editions. Copies of these catalogs can be had free on request to any of the Ingersoll-Rand Co. offices.

New Construction

PROPOSED WORK

Conn., New Haven—J. D. Kauffman, 42 Church St., will install a steam heating plant, vacuum cleaning system, refrigerating plant, etc., in the 5 story, 84 x 114 ft. apartment hotel which he plans to build on Orange and Bishop St. Total estimated cost, $200,000. J. Weinstein, 6 Church St., Arch.

Conn., New Haven—Puglisi & Milici, 20 Wright St., will install a steam heating plant, vacuum cleaning system, electric elevators, etc., in the 4 story, 100 x 101 ft. apartment hotel which they plan to build on Chapel St. and Boulevard. Total estimated cost, $175,000. Marchetti & Davino, 756 Main St., Hartford, Arch.

Conn., Waterbury—The Congregation of the Church of the Immaculate Conception will install a steam heating system in the church which it plans to build on East Main St. Total estimated cost, $100,000. Luke Fitzsimmons, 97 East Main St., Pastor. J. A. Jackson, 1133 Broadway, New York City, N. Y., Arch.

N. Y., Bath—The County Dairymen's League will install steam equipment and ammonia system in the dairy plant which it plans to build here. Total estimated cost, $150,000. M. W. Davison, Dir.

N. Y., Black River—The Northern New York Utilities, Inc., 58 Public Sq., Watertown, plans to construct a concrete power house on the Black River to accommodate 3 vertical 1000 kw. generating units; also build a power canal. J. B. Taylor, Pres.

N. Y., Brooklyn—The Board of Education, 500 Park Ave., New York City, will install a steam heating system in the 5 story, 118 x 192 ft. school which it plans to build on Dumont Ave. between Wyona Ave. and Vermont St. Total estimated cost, $543,474. C. B. J. Snyder, Municipal Bldg., New York City, Arch. and Engr.

N. Y., Brooklyn—The Kings Highway Corporation, 1817 Kings Highway, will install a steam heating system in the 2 story, 104 x 120 ft. theater which it plans to build on Kings Highway and East 12th St. Total estimated cost, $175,000.

N. Y., Carthage—The Carthage Sulphite Pulp & Paper Co., Front St., plans to repair and build additions to its boiler house and install equipment in same. Address C. E. Eaton.

N. Y., New York—Baker, Carver & Morrell, 39 Water St., will install a steam heating system in the 9 story, 28 x 83 ft. office and loft building which they plan to build at 37 Water St. Severence & Van Allen, 4 West 37th St., Arch.

N. Y., New York—The Buick Auto Repair Shop, 244 West 49th St., will install a steam heating system in the 1 story, 100 x 200 ft. garage which it plans to build on 54th St. near 8th Ave. A steam heating system will be installed in same. Total estimated cost, $400,000. T. J. Bird, 101 Park Ave., Arch.

N. Y., New York—H. Claman, 241 West 43rd St., will install a steam heating system in the 10 story, 100 x 100 ft. hotel which he plans to build on 43rd St. near 8th Ave. Gronenberg & Leuchtag, 241 West 43rd St., Arch.

N. Y., Syracuse—The Onondaga County Orphans Home plans to install heating and drainage systems in the 10 cottages which it plans to build. B. J. Hotaling, Supt.

N. Y., Syracuse—The Onondaga Milk Producers Co-operative Association plans to build a milk condensary and would like to receive prices on boilers, condensers, handling devices, etc., which will be installed in same. Estimated cost, $150,000. Address C. L. Amos, 1204 James St.

N. Y., Watertown—The Northern New York Utilities, Inc., 58 Public Sq., plans addition to generating plant at Effley Falls. Project includes the construction of a 30 x 38 ft. power house to accommodate 1 vertical generator with governor, revamping dam, etc. J. B. Taylor, Pres.

N. Y., Watertown—The Northern New York Utilities, Inc., 58 Public Sq., plans to develop power on the Oswegatchie River at Browns Falls. Project includes the construction of a power house, dam, 3 vertical generating units, flume and tail race. Address J. B. Taylor.

Penn., Chester—The Foster Hotel Corporation is having plans prepared by E. Allen Wilson, Arch., 1208 Chester St., Philadelphia, for the construction of a 4 story, 118 x 228 ft. hotel at 9th and Welsh St. A steam heating system will be installed in same. Total estimated cost, $250,000.

Penn., Reading—W. I. Luden Co., 216 North 8th St., will install a heating plant consisting of a low pressure boiler, electric elevators and pipes with radiators in the 4 story, 100 x 156 ft. mill building which it plans to build. Total estimated cost, $75,000. Address A. N. Bodey, Gen. Mgr.

Md., Cumberland—The Berwin-White Coal Mining Co., plans to construct a power plant, which will furnish current to the company's 8 mines in Windber, near here. Estimated cost, $800,000.

Md., Baltimore—E. H. Josselyn, 704 North Durham St., will install a steam heating plant, boiler and engine for power in the 4 story, 25 x 125 ft. addition which it plans to build to its candy factory. Total estimated cost, $15,000. Callis & Callis, 2055 Kennedy Ave., Arch.

Md., Cumberland—The Kelly-Springfield Tire Co., Cook St., Akron, Ohio, plans to construct several additions to its plant to include a power plant and electric-light system. Total estimated cost, $2,000,000 to $2,500,000. H. B. Blanchard, c/o company, Engr.

Va., Norfolk—R. T. Lipscombe, 34 Virginia National Bank Bldg., and others, plans to build an ice, cold-storage and dehydration plant. Estimate cost, $225,000. B. Mitchell, Seaboard Bank Bldg., Arch.

Va., Alexandria—The Bureau of Supplies & Accounts, Navy Department, Washington, D. C., will soon award the contract for installing 2 exhausters and 2 constant duty motors at the Navy Yard here. Schedule No. 7817¾.

N. C., Charlotte—The city will install steam heating and ventilating systems in the 3 story high school which it plans to build. Total estimated cost, $135,000. E. Sayward, Chamber of Commerce Bldg., Atlanta, Ga., Arch.

Fla., Winter Garden—The city plans election to vote on from $30,000 to $35,000 bonds to build complete water supply system, to consist of oil pumping engines, brick pumping station, etc. W. Ginn, Sanford, Engr.

Ala., Birmingham—The Birmingham Ry. Light & Power Co., 2001 1st Ave., plans to install a new water gas set. Estimated cost, $75,000. H. E. Cox, Ch. Engr.

La., Kaplan—The city plans to reconstruct the water-works and light plant. Estimated cost, $40,000. X. A. Kramer, Magnolia, Miss., Engr.

Ohio, Cleveland—The Ullman-Philpott Co., 4805 Lexington St., is in the market for various motors, ranging from 3 to 30 hp. in phases from 2 to 3, alternating current.

Ill., Chicago—Ascher Bros., 220 South State St., will install a steam heating system in the 1 story, 155 x 200 ft. moving picture theater which they plan to build on 92nd St. and Commercial Ave. Total estimated cost, $250,000. H. L. Newhouse, 4630 Prairie Ave., Arch.

Ill., Gillespie—The Board of Education will install a steam heating system in the 2 story, 140 x 154 ft. high school which it plans to build. Total estimated cost, $125,000. J. W. Kennedy, Cahokia Bldg., East St. Louis, Engr.

Ill., Watertown—The State Legislature plans to install an artificial ice machine having a daily capacity of 10 tons, at the Watertown Hospital for Insane.

Kan., Lyons—The City Council plans to extend the waterworks system; will also install pumps for 2 new wells.

N. D., Dickinson—The Budget Committee, Capitol, Bismarck, plans to build a heating plant at the State Normal School here. Estimated cost, $35,000.

Mo., Macon—W. H. Martin, City Clk., will receive bids until March 20 for improving power plant. Estimated cost, $45,000. F. L. Wilcox, Syndicate Trust Bldg., St. Louis, Engr. Noted Feb. 4.

Mo., St. James—The Missouri State Soldiers' Home plans to install new power house equipment at the home here. Estimated cost, $7,600. W. V. Farris, Pres. Bd. Mgrs.

Mo., St. Joseph—The city plans an election soon to vote on bond issue for improving the lighting plant. Hale Judson, City Engr.

Colo., Denver—The Jackson Compressor Co., 235 South Cherokee St., will soon receive bids for the construction of a 1-story electric furnace plant. Estimated cost, $225,000.

Colo., Sterling—The city voted in favor of a $16,000 bond issue for building a transmission line from Sterling to Tecumseh.

Ore., Astoria—The Pacific Power & Light Co., Spalding Bldg., Portland, plans to build a 4500 hp. electric generating plant at the foot of Astor St. J. B. Kilmore, Dist. Mgr.

Cal., Elsinore—G. I. Lamy, Engr., Marsh-Strong Bldg., Los Angeles, has applied to the State Water Commission for permission to appropriate 120 second feet of waters of Lake Elsinore to irrigate 20,000 acres of land. Plans include the construction of power and pumping plants, etc. Total estimated cost, $1,000,000.

Cal., Hanford—The California Packing Co., 101 California St., San Francisco, plans to construct a power house in connection with the 1 story, 110 x 250 ft. fruit packing plant which it will build. P. Bush, 101 California St., San Francisco, Engr.

Cal., Long Beach—The city has authorized W. T. Lisenby, Mayor, to investigate the feasibility of building an electric light plant and purchasing distributing system owned by the Southern California Edison Co., Los Angeles. D. S. Miller, City Engr.

Cal., Mare Island (Vallejo P. O.)—The Bureau of Supplies & Accounts, Navy Department, Washington, D. C., will soon award the contract for installing motor generator set at the Navy Yard here; Schedule No. 7815¼.

Cal., Mare Island (Vallejo P. O.)—The Bureau of Yards & Docks, Navy Department, Washington, D. C., plans to install motor and blading for turbo-alternators in Navy Yard, here. Estimated cost, $7500.

Cal., Merced—The Merced Union High School Dist. plans to build a power house, administration and assembly building, etc. in connection with the group of high school buildings which it plans to construct. Estimated cost, $130,000. Allison & Allison, 1405 Hibernian Bldg., Los Angeles, Arch.

Que., Ste. Agathe—A. Gagnon, Secy. Department of Public Work and Labor, Quebec, will receive bids until March 14 for the construction of power house, heating and plumbing, electric wiring, etc., at the Laurentian Sanatorium here.

Ont., Bowmanville—The Polusterine Products Co., 170 Ontario St., will move its plant from Toronto to Bowmanville, and is in the market for a 25 hp. steam boiler, 2½ hp. electric motor, 150 galion steam kettle, etc. H. V. Hohs, 170 Ontario St., Toronto, Mgr.

Ont., Orillia—The Department of Public Works, Toronto, will receive bids until March 31 for the construction of a 5 story power house and hospital on Main St. Estimated cost, $40,000 and $25,000 respectively.

Ont., Ottawa—The Board of Control has been authorized to have plans prepared and submit report on the advisability of establishing central heating plant on Albert St. for city hall, police station No. 8, fire hall and registry office. Estimated cost, $80,000 A. F. McCallum, City Hall, Engr.

CONTRACTS AWARDED

N. Y., Utica—The State Hospital Commission, Capitol, Albany, has awarded the following contracts for work at the Utica State Hospital: constructing additional central heating plant, to R. G. Lloyd, 113 South St., cost, $29,832; installing new boilers, to McNaul Boilers Co., 983 Front St., Toledo, Ohio, $58,130; heating work, piping, etc., to W. B. Armstrong Co., Fulton St., Albany, $39,640. Noted Feb. 25.

N. Y., Wards Island—The Bureau of Yards & Docks, Navy Department, Washington, D. C., has awarded the contract for installing refrigerating plant equipment at the Naval Hospital Reservation here, to Frick Co., Inc., West Main St., Waynesboro, Penn. Estimated cost, $21,074 (93 days). Noted Feb. 18.

Penn., Philadelphia—The L. W. Hirsch Co., 923 Market St., has awarded the contract for the construction of a 5 story, 40 x 200 ft. department store at 925-27 Market St. to Melody & Keating, 1322 Race St. A steam heating system will be installed in same.

N. D., Jamestown—The Bridgeman-Russell Co. has awarded the contract for the construction of a 2 story, 30 x 60 ft. addition to its steam generator and condensing plant, to the Northern Construction Co., Grand Forks.

Ore., Astoria—The Astoria Flouring Mills Co. has awarded the contract for installing an 800 hp. electric motor, 48 stand rolls and 16 shifters in its new mill to the Nordyke Marmon Machine Co., 250 North Meridan St., Indianapolis, Ind.